Compressed Air Magazine

VOLUME 46 · NUMBER 11 NOVEMBER 1941 LONDON · NEW YORK · PARIS

DERRICK OPERATOR AT FRIANT DAM

ON THE COVER

OUR cover picture shows an operator at the controls of a 180-foot-boom, stiff-leg derrick used in placing concrete at Friant Dam. Guided by telephone messages and bell signals, he lifts a 4-cubic-yard bucket of concrete from a car on an overhead trestle, lowers it, and spots it exactly where it is wanted, although he cannot see where it is going.

●

IN THIS ISSUE

SEVERAL innovations in concrete mixing and placing are described by Henry W. Young in the second part of his article on Friant Dam. Also recounted are the numerous and varied uses of compressed air of which, surprisingly, greater quantities are now required than during the excavating stage of the operations.

●

RAINBOW BRIDGE at Niagara Falls (Page 6584) was built to replace the ill-fated "Honeymoon Bridge." Appropriately, therefore, the new structure was opened on October 19 by Mr. and Mrs. John Martin, who became husband and wife on that day, and by Mr. and Mrs. Albert B. Paul, who honeymooned at Niagara Falls 65 years ago.

●

THE Portland Mine, which has yielded about fifteen cents of every dollar's worth of gold produced in Cripple Creek, has been drained of 700 feet of water and the way cleared for resuming mining in its lower workings. A 2-page article tells how it was dewatered by driving a raise from the Carlton Tunnel to its winze level.

●

FROM a railroad right of way to a highly ramified and profitable mining enterprise, is the story of the Hecla Mining Company in a nutshell. Its original mine has now become a group of mines, with accessory plants for treating the ores that are produced, and further expansions are underway. The interesting history of this outstanding organization is told by H.W. Ingalls, editor of the *Wallace* (Idaho) *Miner.*

Compressed Air Magazine

Volume 46 — NOVEMBER, 1941 — Number 11

C. H. Vivian, *Editor*
J. W. Young, *Advertising Manager*
A. M. Hoffmann, *Assistant Editor*
J. F. Kenney, *Business Manager*
D. Y. Marshall, *European Correspondent,* 243 Upper Thames St., London, E.C.4.
F. A. McLean, *Canadian Correspondent,* New Birks Bldg., Montreal, Quebec.

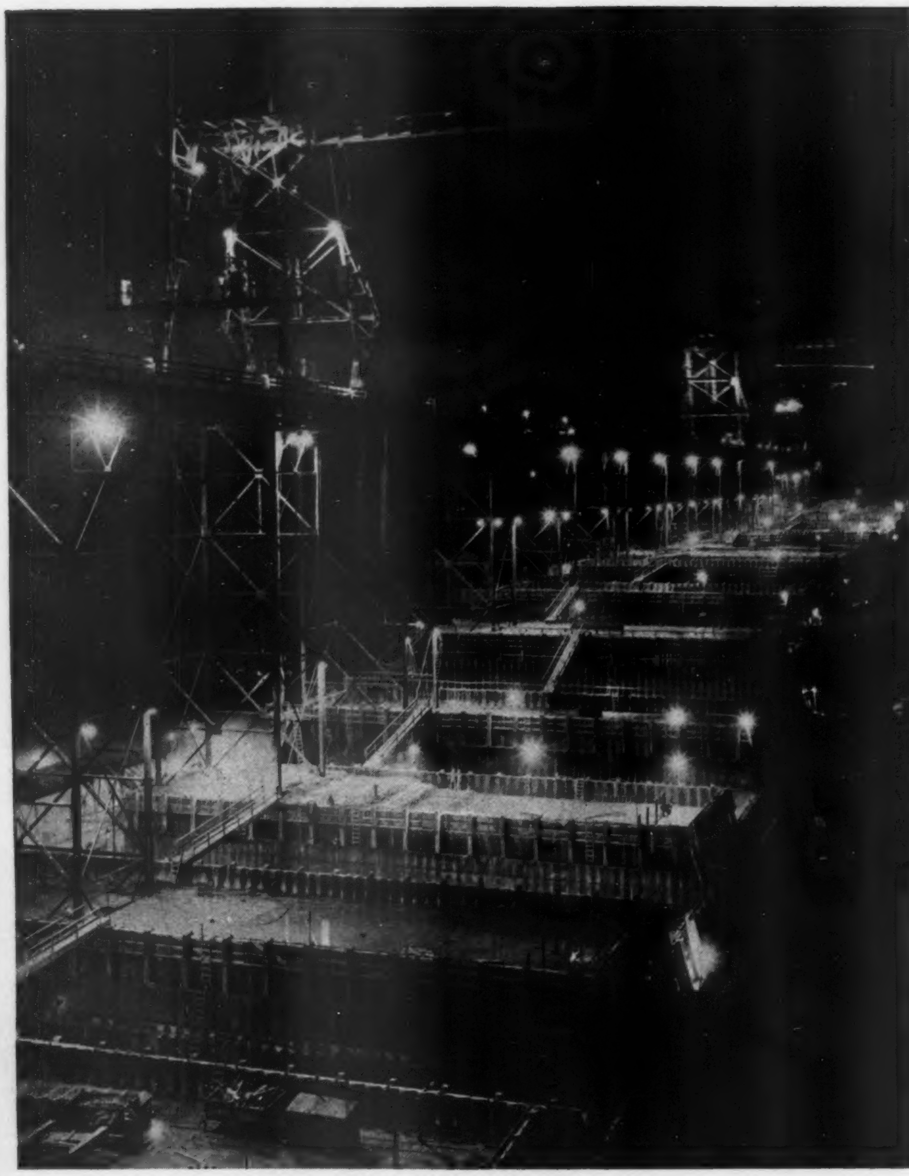
EDITORIAL CONTENTS

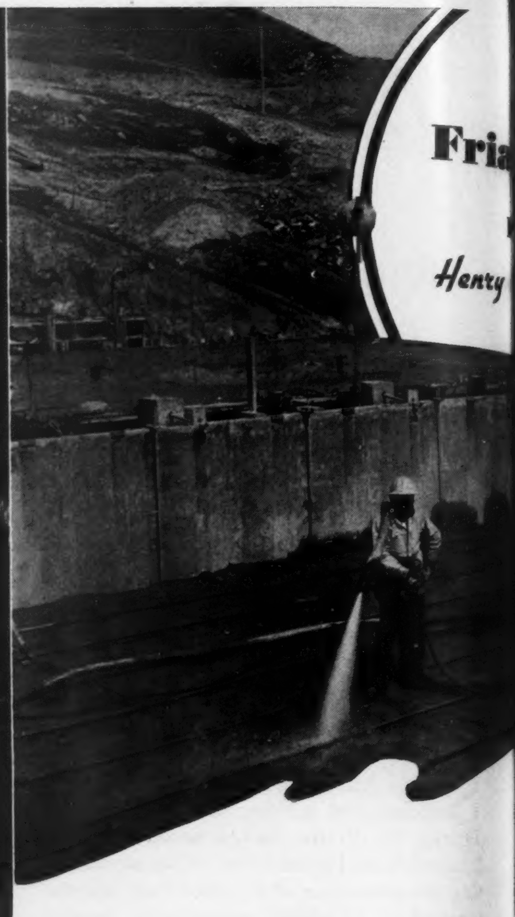
ADVERTISING INDEX

A monthly publication devoted to the many fields of endeavor in which compressed air serves useful purposes. Founded in 1896.

CCA Member Controlled Circulation Audit.

Published by Compressed Air Magazine Company. G. W. Morrison, president; J. F. Kenney, vice-president; F. E. Kutz, secretary-treasurer.
Business, editorial, and publication offices, Phillipsburg, N. J.
Advertising Office, 11 Broadway, New York, N. Y., L. H. Geyer, representative.
Annual subscription price: domestic, $3.00; foregin, $3.50. Single copies, 35 cents.
Compressed Air Magazine is on file in many libraries and is indexed in Industrial Arts Index.





THE DAM TAKES FORM

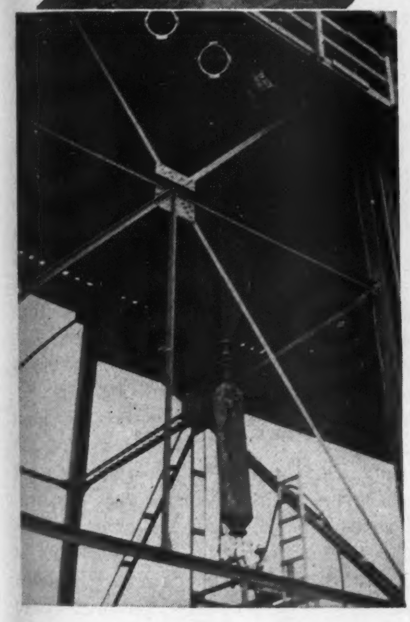
Work goes on around the clock, and at night the growing structure is ablaze with twinkling lights (above). It will be noted that each concrete form extends clear across the thickness of the dam instead of being divided into 50x50-foot blocks, as was the case in earlier large dams in the West. This has been made possible by utilizing measures that reduce the maximum temperature attained by the concrete in setting which, in turn, lessens shrinkage. The view at the far right shows a 4-cubic-yard bucket of concrete being dumped on bedrock. Pipes through which water is circulated to hasten the cooling have been previously placed, being bent so as to follow the contours of the rocky floor. Concrete is poured in successive lifts five feet thick. Before a lift is added to a block previously poured, the surface of the latter is carefully scoured with a wet sand blast, as shown in the center. High-pressure water is delivered through the larger hose. At the nozzle, sand is fed into it through the smaller hose by means of compressed air. The sand, which is dried to facilitate its flow, is dumped into a hopper suspended from the trestle surmounting the dam (small picture). From the hopper it drops into a cylindrical container. A valve at the top of the cylinder is closed and compressed air is admitted to force the sand through the hose leading to one of the blasting nozzles.

AMONG the interesting methods introduced at Friant Dam for the first time on a large scale is that of precooling the water, aggregates, and cement to produce concrete that will be as cold as possible at the time of pouring. It should be borne in mind that concrete generates heat in setting, and that the temperature in the region where the dam is being constructed is regularly around 105°F. and reaches 110° and more.

C. T. Douglas, concrete engineer for the U.S. Bureau of Reclamation, has explained the whole procedure in some detail. When the cement is received in the cars, it still retains some of the heat of manufacture. In August, for example, the maximum temperature (car temperature) of the material was 240° while the average for all the cement so far delivered has been 169°. In the car-unloading system the compressed air used to transfer the material has a temperature of approximately 255°. This further aggravates conditions. To lower it, a 32° water cooler was put on the pipe leading from the compressor to the pump tank, with the result that the temperature of the air is reduced to 180°. The average elapsed time between the entry of the cement in the silos and its delivery to the mixing plant is about two days. In that interval it cools down to about 152°, and when it finally arrives at the mixing plant its temperature has dropped to 138°.

By sprinkling the aggregates with 60° river water at the track hoppers, their summer temperature at the batcher is brought down to an average of 76°. But that is not all. By adding to the water that goes into the mix about 20 per cent by weight of slush ice, a further marked reduction in the temperature of the concrete is effected. Determination to do this meant taking the largest compressor from its regular work and turning it into an ice-making machine by the substitution of an ammonia compression cylinder for the air cylinder.

Three Pak-ice machines of the Vilter type, used commercially in producing slush ice, serve to expand the ammonia. This takes place in each case in a revolving cylinder, mounted in a housing. Water sprayed on the surface of the cylinder freezes, and the ice is shaved off by a knife and added to the mixing water. This is a continuous process, and the result is pronounced because of the great absorption



of heat from the concrete incidental to transforming water from the frozen state to a liquid at 32°F. Just cooling the mixing water to 32° would have comparatively little effect. It is in melting that the ice draws heat out of things.

Because of these various methods of precooling, concrete leaves the mixers at approximately 70°. Without their aid it would come out at about 93 to 94°. Low-heat cement with a 20° rise is used, thus bringing the temperature of the concrete up to about 90° at the initial set. As nearly as can be estimated, the material reaches its maximum temperature after placing in ten days less time than it would if it were not precooled. This, in turn, means that much less time between pours.

Another "first" so far as dam construction is concerned is the admixture of pumicite with cement. It was tried in building the San Francisco-Oakland Bay Bridge and was experimented with at Grand Coulee Dam with results that warrant its use in substantially all the concrete being placed at Friant. The principal advantage of pumicite is that it assists in reducing the maximum temperature of concrete and, consequently, the maximum shrinkage. This makes it possible to pour individual blocks the entire width of the dam (a maximum distance in the case of the lower ones of 370 feet) at one time instead of in the usual 50-foot-square sections. The effect of this is to speed up construction by permitting earlier grouting and, hence, earlier completion. This, along with precooling of the ingredients, shortens the period between pouring and cooling sufficiently to grout from the usual 60 days to as little as 21 days.

The use of pumicite has other advantages. When this inert material is mixed with cement in the proportion of 80 per cent cement and 20 per cent pumicite, the saving effected is equal to the difference in cost between the two. This is considerable, in view of the fact that there is an excellent deposit of pumicite about 2 miles from the dam site. Furthermore, it is said to retain sufficient moisture to aid materially in curing. On the other side of the balance sheet, it affects the strength of the concrete. Ordinary concrete 28 days old has a strength of approximately 4,500 pounds per square inch, while that of pumicite-concrete is only around 3,000 pounds. But in 90 days they are about equal. The low initial strength of pumicite-concrete means that it is not safe to remove the forms until 36 hours after pouring instead of in the usual 24.

Pumicite is volcanic dust, and that found near Friant was deposited there in remote times in a lake, where it settled to the bottom. The body of water dried up ages ago, leaving an easily workable bed of excellent quality. All that is necessary is to strip a few feet of overburden and low-grade pumicite to lay bare the almost white stratum of pure pumicite. This is

PUMICITE DEPOSIT

Friant Dam is the first structure of its kind to be built of concrete containing pumicite which, added to the cement in the proportion of 1 to 4, lessens the temperature rise in setting and has other advantages. Pumicite is a volcanic dust, and there is a deposit of it near Friant that was laid down in a lake that has since dried up. This picture shows the face of the deposit. The man is indicating the cleanest and purest layer which is the source of the material used.

excavated with a 1¼-yard shovel and loaded in dump trucks which haul it to a hopper at the mixing plant. Large lumps are crushed by rolls: smaller pieces are reduced by the grinding action of the aggregate in the mixers until the pumicite is finer even than cement, filling the voids between the particles of cement. From the rolls it is transported to a steel silo, and from there by a 24-inch belt to a bin in the batching plant.

There is one mixing plant on the job consisting of four Koehring 4-yard tilting-type mixers. These are set to discharge through a central collecting cone chute into 4-yard buckets as they are successively spotted below it. The batching plant, together with the automatic recording equipment and the control system, is of the standard C.S. Johnson type. A collecting hopper, with a swivel chute at the bottom, receives the ingredients as they come from the weighing batchers and charges the mixers. In addition to the batchers provided for sand, gravel, and cement, there is one for weighing out the pumicite and feeding it to the hopper. The four mixers make a complete cycle—16 cubic yards—in 2½ minutes, including about fifteen seconds for charging.

Concrete placement on Friant Dam is done from a steel trestle, 2,300 feet long, which is gradually embedded in the dam as it rises. Hoisting equipment on the trestle consists of two Colby Steel & Engineering Company cantilever cranes or hammerheads with booms 294 feet in length. Elsewhere on the job are two American Revolver cranes with 125-foot booms (later to be extended to 137½ feet) and two 180-foot-boom, stiff-leg derricks, making six rigs in all. By means of this hoisting machinery the concrete buckets are picked up from the cars and lowered anywhere in the dam area. Seven cars are used to do the hauling. Each carries four loaded buckets, leaving a space in which to set an empty, and is drawn by a 10-ton General Electric locomotive.

On the dam site where the concrete blocks are being poured, the scene is much the same as on any large contract of this character. The material is placed in 5-foot lifts and compacted by means of vibrators. When set, the surface of each lift is thoroughly cleaned and roughened by blasting with sand and a powerful jet of water before the next one is poured so as to assure a firm bond between the two. On top of each are laid the pipes for the cooling system. By a comparatively new technique applied at Friant, the water is started through these pipes before another lift is added. It has been proved that this helps to dissipate the heat of hydration and keeps the maximum temperature rise of the concrete down to 20°. The water pumped through the system is taken from the San Joaquin River.

Still another departure from usual practice is the 100 per cent use on the job of cantilever forms. They were resorted to in the beginning in order that absorptive form linings could be utilized economically in pouring certain sections of the dam (all the downstream face and the upper 75 per cent of the upstream face) that will be exposed to the erosive action of intermittent wetting and drying with changes in reservoir level. In the meantime, however, they have been generally adopted because they have been found to be well suited for all the work, including contraction joints.

Celotex form-lining board is used wherever a dense, smooth surface is desired. It is easily cut and fastened to the forms with fourpenny casing nails and later stripped from them because water ruins the material for further application. But the results obtained are well worth the slight additional cost, for the concrete is virtually "case-hardened" to a depth of about ¼ inch and is as smooth as the absorptive lining. The surface is free from those small craters that soon give

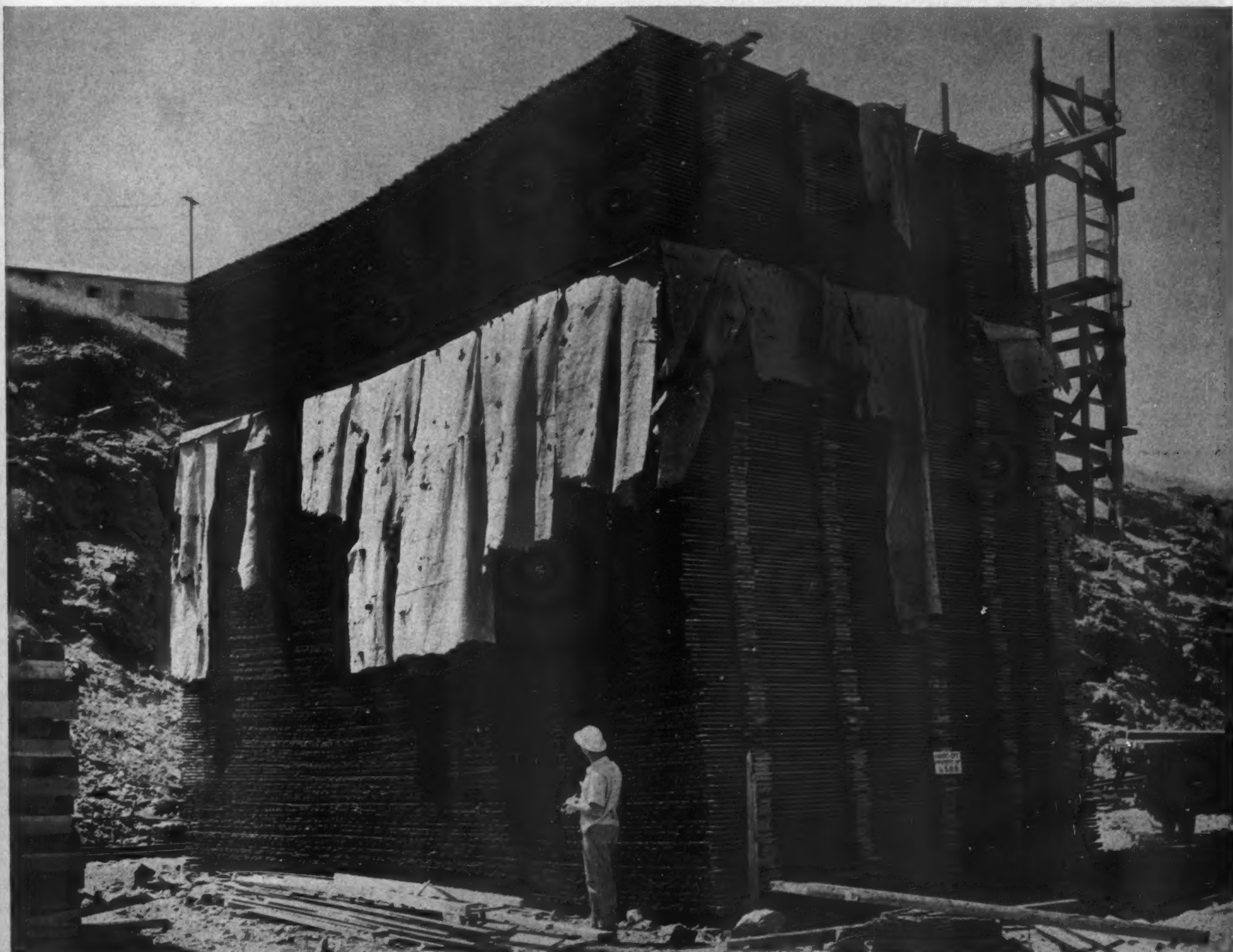
running water and frost a chance to start their destructive action. Being porous, the lining absorbs and dissipates the excess surface moisture that ordinarily tends to form bubbles and thus causes pitting. It serves also as a storage place for water needed for the proper curing of concrete.

Grouting of the foundation and the dam to make them tight against a 320-foot head of water, or a pressure of nearly 140 pounds per square inch, is being done in two stages, as follows: Preparatory to placing concrete, three rows of shallow holes were drilled the length of the foundation, and into these was injected a mixture of pure cement and water with air at relatively low pressure. After the dam reaches a certain height, a line of deep holes is put down for high-pressure grouting. These holes are mostly 2 inches in diameter, are placed on 5-foot centers, and penetrate the rock beneath the structure to depths ranging from 50 to 200 feet. They are drilled from galleries in the dam through pipes set in the concrete as the work progresses; and the grout is forced through them under pressures up to 500 pounds per square inch, forming an impervious curtain extending hundreds of feet down into the river bed. With the second-stage grouting finished, drain holes will be drilled on 10-foot centers to a maximum depth of 75 feet. This is a precautionary measure, the holes affording outlets for any water that might seep through unfilled fissures.

Eventually, all the expansion joints between blocks will be grouted through the medium of pipes embedded in the dam as each lift is poured, there being outlets on 8-foot centers at every other keyed joint and staggered the full height of the structure. This will be done after most of the cooling and shrinkage has taken place. It should be understood that many years will elapse before the concrete will be cooled to a degree where its temperature will be constant, winter and summer. But most of the cooling is effected in a definite and relatively short period at the end of which the seams between blocks can be safely filled with neat cement to form a monolithic mass.

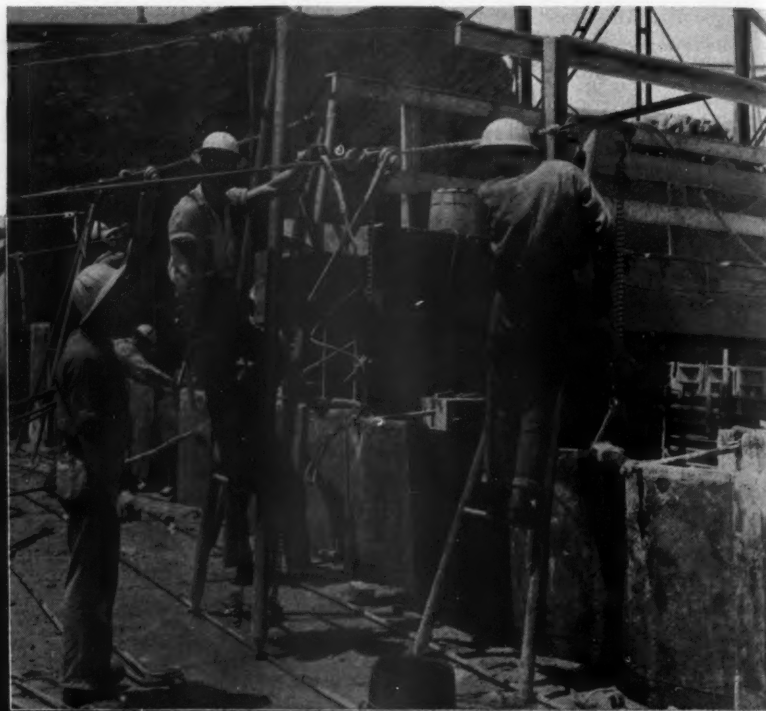
Compressed air for the numerous requirements on the job is supplied by a total of twelve machines, stationary and portable units, and is delivered to the various points of use by two pipe lines extending across the river. One of these is on the downstream side of the dam and is 3,000 feet long, while the other is on the trestle spanning the site and is 4,000 feet in length. The latter has hose connections every 100 feet, a little closer together than those in the shorter line.

With the rock drilling out of the way it would seem that there would be less demand for air. But this is not the case. Much air is needed to pump the cement some 2,000 feet up a 35 per cent grade through the 8-inch line leading from the silos to the mixing tower. In the concrete mixing plant the big pneumatic rams that tilt the four mixers once every 2½ minutes take considerable air, as do the batcher rams. These rams not only have a high-pressure but also a low-pressure side, the latter serving as a buffer to cushion the repeated impact shocks. Pumping calls for a large volume of air,



PIPE THAT WILL GO INTO DAM

Some of the 800 miles of pipe being placed in the dam to carry water for cooling the concrete. It is embedded in the mass as construction proceeds. After it has served its purpose, it will be filled with grout.



CONCRETING OPERATIONS

Among the innovations in concreting practice are the exclusive use of cantilever forms and the lining of the forms with absorptive material wherever a smooth, pit-free surface is desired. The latter will produce what amounts to a case-hardened exterior, and the 2,500,000 square feet of surface that the dam presents will look better and resist the action of frost and running water longer as a result. At the left, carpenters are shown putting some of the lining board in place. Above, a workman is removing moisture from the lining with an electric drier prior to concrete pouring. The raising of forms with special tackle is shown at the top. The other picture shows the maze of reinforcing steel for pouring one of the four 110-inch circular passageways that will carry the river through the dam during the construction period.

for water has to be removed from one place or another at all times. Thirty-five Ingersoll-Rand sump pumps are maintained for this purpose—ten Size 35's and 25 Size 25 units. These were extensively used to pick up drainage water until the concrete blocks were high enough to divert it to regular drains.

For cleaning the surface of the concrete between lifts to assure a firm bond the contractor utilizes a special nozzle that delivers a stream of high-pressure water carrying sand. To flow without clogging before admixture with the water the sand must be dry, and is fed from a tank that hangs from the trestle. The material is dumped into a hopper and screened before entering the tank, which is connected by a 4-inch straightway valve to a cylindrical container, as an accompanying picture shows. The cylinder is filled about two-thirds full of sand; the valve is closed; and compressed air is admitted, the pressure exerted against the free surface of the abrasive material forcing it out through the connecting hose to the nozzle, where it is caught and transported by the water. There are many other demands for compressed air on Friant Dam. In the carpenter shop where the cantilever forms are manufactured it operates saws, augers, and sanders. Elsewhere on the site it performs a variety of services such as riveting, reaming, chipping, and grinding.

In control of these varied and complex operations is an electric system that is a marvel of efficiency considering its temporary character. There is no time, nor would it be economical, to wire the entire area as one would an industrial plant, for example, where the system would be a permanent feature. Nevertheless, wherever a signal can be given by electrical means, or a remote-control switch located that will speed up an operation or provide for the safety of the men, it is there and in perfect working order.

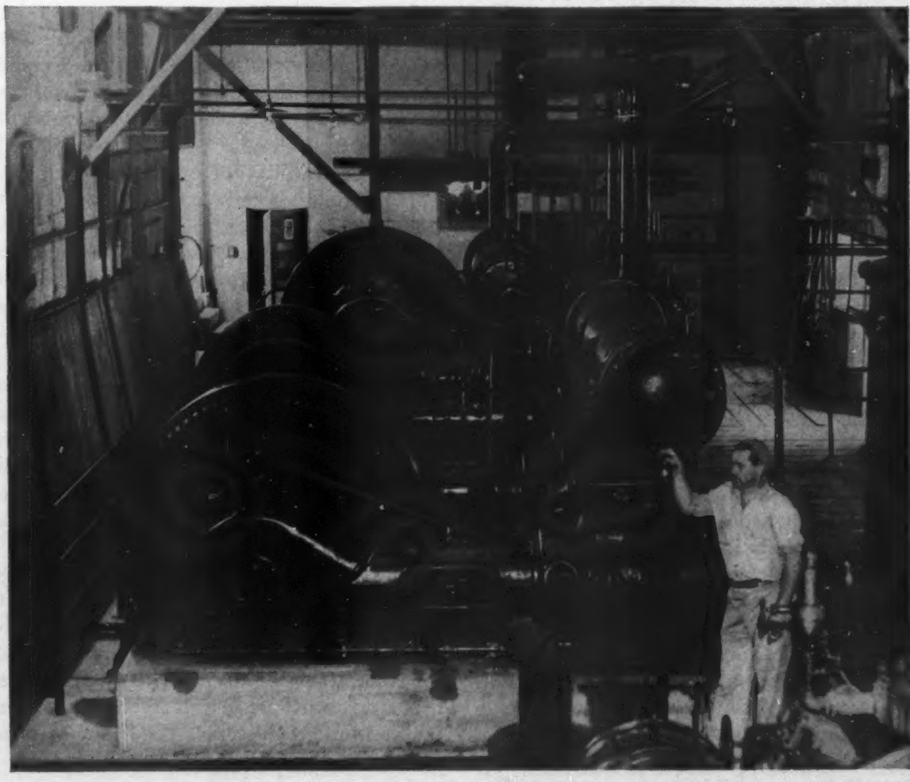
Out in the gravel pit, it will be remembered, are two divergent feeder belts leading to the common stock belt. It would seem to be a simple matter to throw a switch at some point and start the whole conveying system at one time. But that would not do at all. The associate parts must be started in sequence—the stock belt must be going at full speed before the feeders can be allowed to dump material on it, and the feeder belts, in turn, must be running before the eccentric feeders under the grizzlies can begin piling the material on them. Otherwise there would be a serious jam. Similarly, the belt from the stock pile, the scalping screen, crusher, plate feeders, screens—everything in this perfectly coördinated aggregate processing plant—must be set in motion in proper order. If a screen gets clogged, provision must be made to stop the belts feeding it, but not the screen, and the stopping must be done smoothly. Hence there is need for automatic "kick-outs" and "kick-ins."

Under each aggregate pile is a belt that is not tied in with the others. But the operator must have control of each of the four sizes of gravel and two of sand in loading the cars that carry the materials to the main stock piles from which they go by belt to the bins in the batching plant. He has a master switch that loads all trains with the six sizes; but he can also cut out any of the classifications at will. Each hopper holds one carload, and the belt that feeds it is interlocked so that it automatically stops when a full carload has been dumped. The belt cannot be started again until the hopper gate is closed; and red and green position lights on the gate tell the operator what to do and when.

Over on the other end of the job, take the giant hammerheads on the trestle. They are provided with straight Ward-Leonard controls and, in addition, with a load-control relay that regulates the speed with which the buckets are raised after dumping. Ordinarily, the crane whips the empties out of the hole at the rate of several hundred feet a minute. But if for some reason or other a bucket begins its upward journey partly loaded, then the electric finger steps in and automatically increases the torque of the motor, thus reducing the hoisting speed. Jerking it up under those conditions without lowering the speed might endanger those working below and have other disastrous consequences.

Upon the trestle the two hammerheads and the American Revolver cranes are forever ambling back and forth according to the requirements of concrete placing. They are extremely heavy, and to avoid using an excessive quantity of steel in the construction of the trestle it was decided to distribute the load and to operate the hammerheads with not less than 40 feet of space between their nearest wheels. To prevent a dangerous concentration of the load, G.E. Smith, the electrical superintendent, and his workers rigged up two sets of electric eyes, one on each of these big cranes. As a result they cannot be brought closer together than the predetermined distance for which they are set, say 40 or 50 feet. If either one should try to overstep that limit the motors would kick out.

There are all sorts of other electrical contrivances such as a moisture-content indicator for sand at the mixer plant, as well as complete automatic control of the batching and mixing. The sand and gravel bins at the mixing plant are arranged with remote-control gates so that the aggregate man at the mixer cannot select more than one at a time when filling the bunkers over the batcher. Should he inadvertently attempt to do so he would find himself checked by one of the never-failing interlocks on guard.



COMPRESSOR PLANT

Although it would seem that the greatest requirement of compressed air on a job of this kind is for drilling foundation rock, there has been no letup in the demand since that work was completed. Ten air compressors, stationary and portable, were initially used, and two more were added later. This view shows some of the larger machines. The far compressor was converted into an ice-making unit and supplied the slush ice that was used to cool the water for mixing the concrete.

WHERE AIR SERVES

These pictures show several types of Ingersoll-Rand pneumatic tools performing varied tasks in the carpenter yard, where the concrete forms are built. A Wolf link saw driven by an air motor (right) saves time in cutting large timbers. Holes are bored in the wales of cantilever forms with 33SKW woodborers (below). When the metal linings on the forms used for key joints come into the shop for repairs, they are cleaned with Size 4-F Multi-Vane surface buffers (lower right).

According to A.R. Hines, safety engineer of the Bureau of Reclamation, "The contractor at Friant was relieved of the problem and necessity of erecting a large housing camp because of the fact that the majority of the construction workers live elsewhere and therefore commute. It is estimated that some 900 employees with their families live in the City of Fresno and therefore travel by automobile 40 miles each day. At least 100 live in the vicinity of the nearby Town of Clovis and thus commute a distance of 25 miles. The remaining 400 or so employees are distributed throughout the Town of Friant and in the many auto-trailer camp sections on both sides of the San Joaquin from 2 to 5 miles downstream from the dam site." A contractor's camp, providing limited housing facilities, has, however, been constructed. It consists of an administration building, two 48-men dormitories, a mess hall seating 120, and a well-equipped hospital and first-aid station.

"While the housing requirements were thus minimized for the contractor, it was necessary," continues Mr. Hines, "to provide ample facilities in the way of large automobile parking spaces to accommodate the stream of daily commuters. The contractor therefore constructed three separate but interconnected parking areas on three different levels just inside the main-gate entrance, each providing space for 175 cars to take care of the day shift. About 100 cars are parked on each level when the 'swing' and 'graveyard' shifts are working.

"The government initiated preliminary steps whereby the attention of the Fresno County Planning Commission as well as of both health and police officials of Madera and Fresno counties was called to the desirability of coöperation on the part of the respective counties to prevent bad housing and sanitation conditions. An ordinance was passed regulating the construction, sanitation and conduct of house courts and tent spaces, providing for the issuance of permits for the operation of same, and prohibiting squatter camps in the incorporated areas of Madera County. Squatter camps were declared a public nuisance and were not permitted. Through this early program of control, local county officials have succeeded in keeping general living conditions above par."

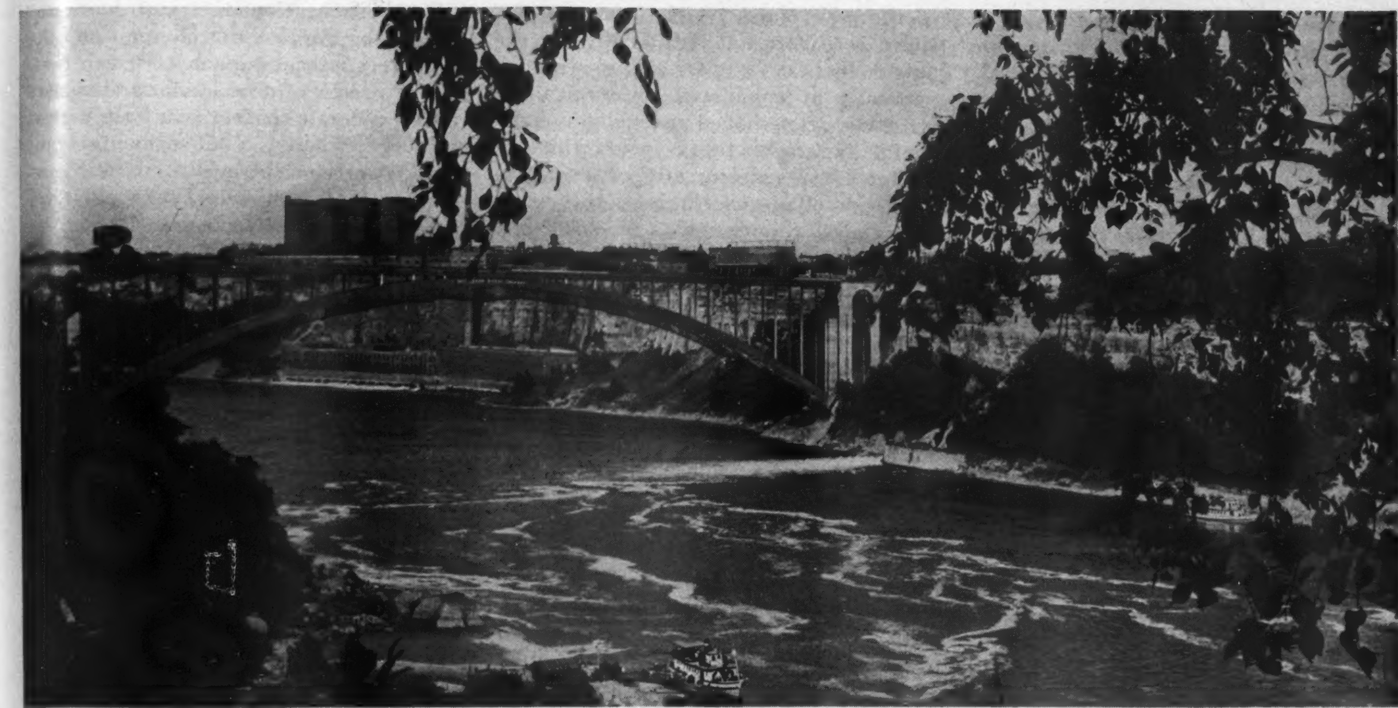
The government camp is a neat little town with a present population of about 200. It includes offices, laboratory facilities, a dormitory, and family residences, all attractively landscaped. The buildings are air conditioned; and adequate water and sewerage systems, together with a sewage-treatment plant, have been provided.

All that has been said so far about the Central Valley Project and Friant Dam has to do with the present. But what of the past? Judging from the remains found in excavating the dam foundation, huge creatures roamed the region many centuries ago. Aside from a few mastodon tusks 6 to 8 feet in length, said to be of comparatively recent origin, there was dug up the backbone of a mosasaur, while the prize discovery was a lizard-type fossil head with all teeth intact. Local geologists determined that the reptile lived at least 500,000 years ago. People are prone to speculate as to how long these massive concrete dams are going to last. Even the engineers and builders can only guess at that; but it is certain that many ages will pass before such lizards will again keep court at Friant.

Friant Dam is being built by the U.S. Bureau of Reclamation, of which John C. Page is commissioner and S.O. Harper chief engineer. R.S. Calland is district engineer of the Central Valley Project, R.B. Williams is construction engineer of the Friant Division (dam and canals), and J.H. Warner is resident engineer on the dam. The contract for the structure was awarded to the Griffith Company and Bent Company, Los Angeles, Calif., the principal contractor, with H. Stanley Bent acting as project manager and M.H. Slocum as general superintendent. E.L. Causey is project engineer for the contractor; P.F. Swartz, office manager; J.V. Devine, master mechanic; and Earl Peacock is chief O.K. man.

The superintendents who are in charge of these varied and far-flung operations are: H.S. Bent, Jr., mixing plant; P.O. Hayes, aggregates; M.B. Kennedy, materials; Del Lundmark, cranes; S.B. Martin, safety; C.A. Mason, excavation; J.A. McGowan, rigging; R.V. Moore, railway and locomotive; L.C. Nesbit, trestle; G.E. Smith, electrical; James Yeomans, clean-up and concrete; Frank Migliaccio, finishing foreman; F.A. Backman, embedded items; James Walker, grouting; Al Geiger, pumps, cement and aggregate transfer; E.W. Simpson, carpentry; and Stanley Stowe, pumicite production.

This is the last installment of the article on Friant Dam. The first one appeared in the October issue.



Photos, Herbert H. Foster and Associates

THE BRIDGE IN PLACE

Showing the rocky walls of the gorge on the New York side of the international stream that swirls by this point with a velocity of 25 to 30 miles an hour. The water is 175 feet deep and approximately 3,000,000 tons of it passes under the bridge every minute. The site of the bridge was dedicated in 1939 by King George VI and Queen Elizabeth of England. More than 50 per cent of those entering Canada from the United States go by way of the Niagara peninsula and most of them will henceforth use this crossing. The bridge was officially opened in October.

Niagara's Rainbow Bridge

R. G. Skerrett

RAINBOW Bridge, the newest crossing over the swift and turbulent Niagara River, is so named because this beautiful international arch span symbolizes in steel the fleeting rainbow intermittently born of the sunlit mists of the two thundering cataracts. It replaces the Falls View Bridge which was destroyed by a great ice jam three years ago.

To evaluate what the designers and constructors of the Rainbow Bridge have done in spanning the cliff tops of Niagara gorge at a point 1,700 feet downstream from the American Fall one should know something about the other structures that have linked the United States and Canada at approximately the same location. The first of these was the 1,268-foot Clifton Suspension Bridge which was placed in service early in 1869. It was supported by timber towers erected at the opposite crests of the gorge, and its floor system, which was suspended from two steel cables, afforded room for only a single 10-foot roadway. Traffic alternated in 1-way movements; and the crossing was mostly used by Ontario farmers who carried their fruits and vegetables to the more profitable markets in neighboring New York State. After serving for sixteen years, the timber towers were replaced by iron ones; and in 1887 two additional cables, with new anchorages, were installed to support a floor broad enough to provide two traffic lanes.

The remodeled structure was finished December 15, 1888. On January 10 of the following year a violent windstorm broke the sway-prevention cables, and the swinging structure frayed and snapped a sufficient number of the suspenders to drop the floor system into the river. Despite that catastrophe the Clifton Suspension Bridge was rebuilt and again ready for use less than five months later. That quaint structure remained in service until 1898, when increased traffic and other developments in the neighborhood resulted in the construction of the Falls View Bridge, a steel arch span that later became popularly known as the "Honeymoon Bridge."

The Falls View Bridge was destroyed by an ice jam that reached its climax on January 27, 1938, and had narrowly escaped a similar disaster in 1899. At that time some of the lower members of the arch structure were injured; but just when the crossing seemed doomed, the backed-up water between it and the falls cleared the channel beneath the ice and both the water and the ice fortunately subsided rapidly. Such was not the outcome three years ago. The ice moved down against the bridge footings like a glacier, towering 50 feet above the mean water level of the river. The thrust of that enormous mass and of the arrested Niagara broke the arch span from its anchorage castings on the American side and pushed that end of the structure into the ice below. The collapse was complete when the Canadian end was torn loose and pulled into the river.

Immediately following the destruction of the Falls View Bridge, steps were taken looking to the early building of a new and far better crossing by the interested public of the Province of Ontario and of the State of New York. An international body, the Niagara Falls Bridge Commission, was created with authority to construct, maintain, and operate a bridge with suitable approaches between Niagara Falls, N.Y., and Niagara Falls, Ont. Revenue bonds totaling $4,000,000 were made available to cover the cost of the span, and bids for its erection were submitted in March of 1940. In the meantime the consulting engineers had considered the relative merits of a suspension bridge and an arch span; and in choosing the latter type they were influenced not only by engineering considerations but by the fact that it would harmonize better with nature's setting and in no wise detract from the scenic grandeur of either the American or the more expansive Canadian Fall.

The first design developed for the Rainbow Bridge embodied a 2-hinge structure

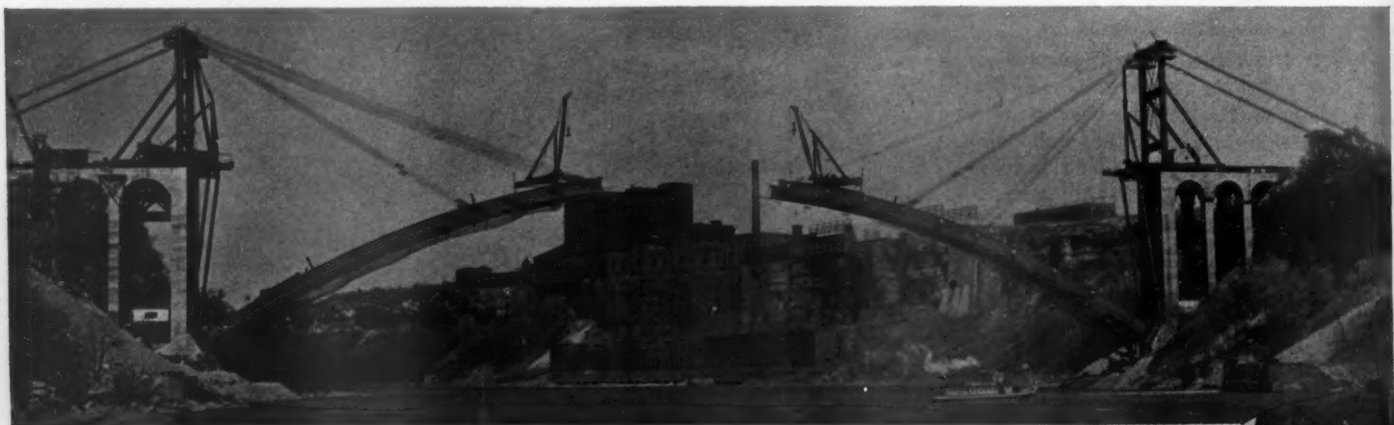
which would have led to some saving in steel. But model tests made at Princeton University disclosed that a hingeless arch, although somewhat heavier, possessed superior characteristics. The hingeless arch of the Rainbow Bridge measures 950 feet from center to center of the opposing skewbacks, where it is anchored, and is said to be the longest of its type built to date. The chord length of 950 feet is 110 feet greater than the corresponding dimension of the main span of the erstwhile Falls View Bridge, and this has permitted placing abutments farther back from the shore lines and to locate the skewbacks at a higher elevation. The centers of the skewbacks are 52 feet above mean water level and 35 feet above high-water level—the stage usually accompanying ice jams. The foundations for the arch of the Falls View Bridge were not more than about 40 feet above the normal level of the Niagara River. The gain in the direction of added security against damage by ice as a result of the longer arch span should now be plain.

The arch of the Rainbow Bridge is formed by two paralleling steel ribs of the closed-box type set 56 feet 2 inches apart from center to center. Each is 12 feet deep and 3 feet wide from center to center of the web plates which form the two sides; is stiffened longitudinally on the outside by heavy angles that are arranged vertically at equidistant intervals; and is further strengthened internally by horizontal diaphragms that coincide with and reinforce the exterior stiffening angles. From the top of each rib rises a succession of spandrel columns, also of closed-box construction. These are rectangular in cross section and support the steel floor system and the spandrel girders. The columns are not sway-braced; but the arch ribs are tied together by extensive lateral bracing.

The deck of the floor system consists of reinforced-concrete slabs and has a total width, between outside curbs, of 60 feet 2 inches. This affords space for two 22-foot roadways that are separated by a 4-foot mall; and a single sidewalk, 10 feet wide, runs along the southern flank of the crossing and gives an unobstructed view of both cataracts. On the New York side, as has already been mentioned, the bridgehead is about 1,700 feet downstream from the American Fall. Because the new structure is 400 feet farther away from the falls than the preceding one, frozen mist drifting down from the plunging waters is less likely to accumulate upon it.

Both on the Canadian and American side of the gorge the arch span adjoins concrete approaches each of which consists of a series of semicircular arches that rest on concrete shafts rising from within the gorge. There is a flat segmental span on the American side of the crossing that passes over the projected Parkway Drive, and on the Canadian side there is a similar one over the River Road. At each end of the bridge are ample arrangements for the dispatch of customs and immigration inspections. Twelve traffic lanes converge upon it from the New York side and fourteen from the Ontario side, with toll booths at each location to handle the stream of motor cars of all kinds that will use the new crossing. The plazas and approaches are being beautifully landscaped in keeping with their proximity to the falls. The total length of the structure, including the two approach spans, is about 1,440 feet.

The arch ribs of the river crossing are supported on concrete abutments set on stepped excavations in the solid rock of the gorge walls, against which the arch thrusts. The columns that support the end panels of both the arch span and the adjacent approach spans also are of concrete. Expansion joints interposed at



HOLDING ARCH UP

Owing to the depth and swiftness of the stream, it was not feasible to use falsework to support the arch during erection. Instead, the engineers employed tiebacks that passed over the top of an erection tower on either side of the gorge and were secured to huge anchorage blocks 150 yards inshore. The picture above shows the structure when the two arch ribs were approaching closure. At the right is a view from the top of one of the erection towers, showing the supporting cables running down to the ribs. The setting of a 63-ton steel grillage on an anchoring abutment at the American side of the river is shown at the far right. It and the skewback later placed on it are bound to the foundation structure by 32 steel bolts, each 32 feet long and 3 inches in diameter. Center—Removing the assembly bolts and riveting up a splice plate on top of an arch rib at the junction of two rib sections.

these junctions adjust themselves to any vertical movement resulting from loading conditions on and temperature changes of the great hingeless arch. This movement may reach a maximum of 12 inches.

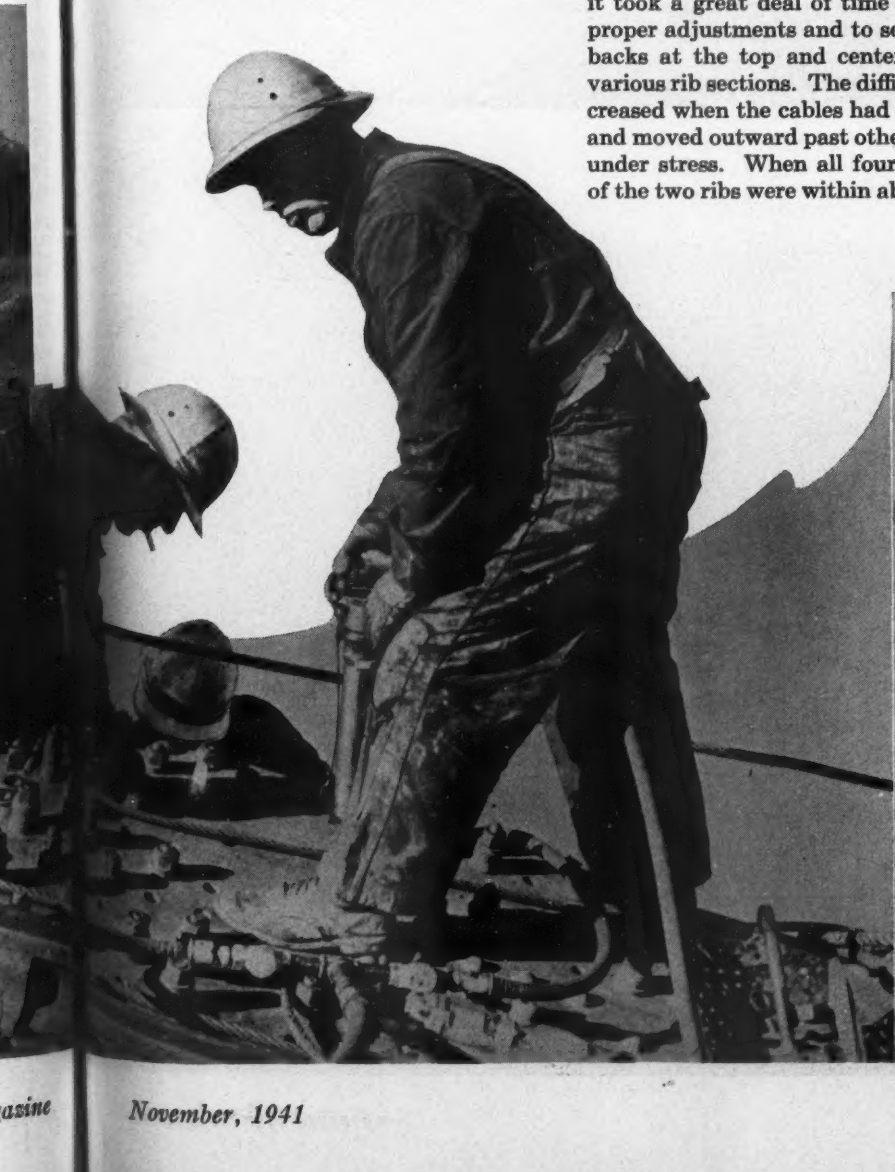
Because of the depth and swiftness of the Niagara at the bridge site, and by reason of the gorge walls which rise there an average of 180 feet above mean water level, the constructors could not have recourse to falsework to support the ribs as they were gradually and simultaneously extended from both sides to a point about 202 feet above the normal surface of the water in the middle of the stream. It was therefore necessary to resort to another method of holding up the lengthening sections. This was done by tieback cables carried up and over a rectangular erection bent or tower which, in turn, had other tiebacks or stays extending rearward for 350 feet to a succession of concrete blocks, each weighing 650 tons, anchored in solid rock. One erection bent was stationed on each side of the river directly over the outermost of the concrete columns of the arch span and rose to a height of 129 feet. It was made up of steel members that were later worked into the bridge and capped by a cross member that held the two columns about 60 feet apart, center to center. Leading rearward from the top of each column to the anchorages were sixteen $1\frac{9}{16}$-inch wire cables.

The rib sections ranged in unit weight from 39 tons to a maximum of 75 tons, while each skewback weighed 46 tons and rested upon a 63.5-ton grillage. All these members had to be lifted, lowered, and moved to their assigned positions in the growing structure. For this purpose there was available on each shore an upper or deck traveler of 85 tons capacity and a lower or arch traveler mounting a 40-ton stiff-leg derrick. The first three sections of a rib were cantilevered out from the grillage and skewback, and to the outer or free end was attached a sustaining group of tiebacks consisting of eight cables. After the following two sections had been assembled they were held up by eight tiebacks. The succeeding two sections were then added to the rib, and because of the accumulating weight twelve cables took up the load. Three sections, totaling 151 tons, came next, and another group of twelve tiebacks sustained that weight and held the rib in its predetermined vertical position. The half rib was then lengthened to the junction point midstream by two more sections, each weighing 53 tons.

The procedure may sound simple, but it was an extremely complicated one; and it took a great deal of time to make the proper adjustments and to secure the tiebacks at the top and center line of the various rib sections. The difficulty was increased when the cables had to be shifted and moved outward past others remaining under stress. When all four half-lengths of the two ribs were within about a foot of meeting, powerful hydraulic jacks, above and below the junction, were used to spread the members apart and to bring them in a position of compression, not tension, so as to measure exactly the final dimensions of the closure pieces, which could then be fashioned in the shop. The closing gap was about 11 inches.

With the ribs completed and braced laterally, the work on the spandrel columns and the floor system followed rapidly. The first rib section was erected near the end of February of the current year; closure of the arch took place on June 12; and the deck was finished about a month later. The bridge alone has cost $3,470,000, and the plazas and buildings have raised the total outlay to $3,760,000.

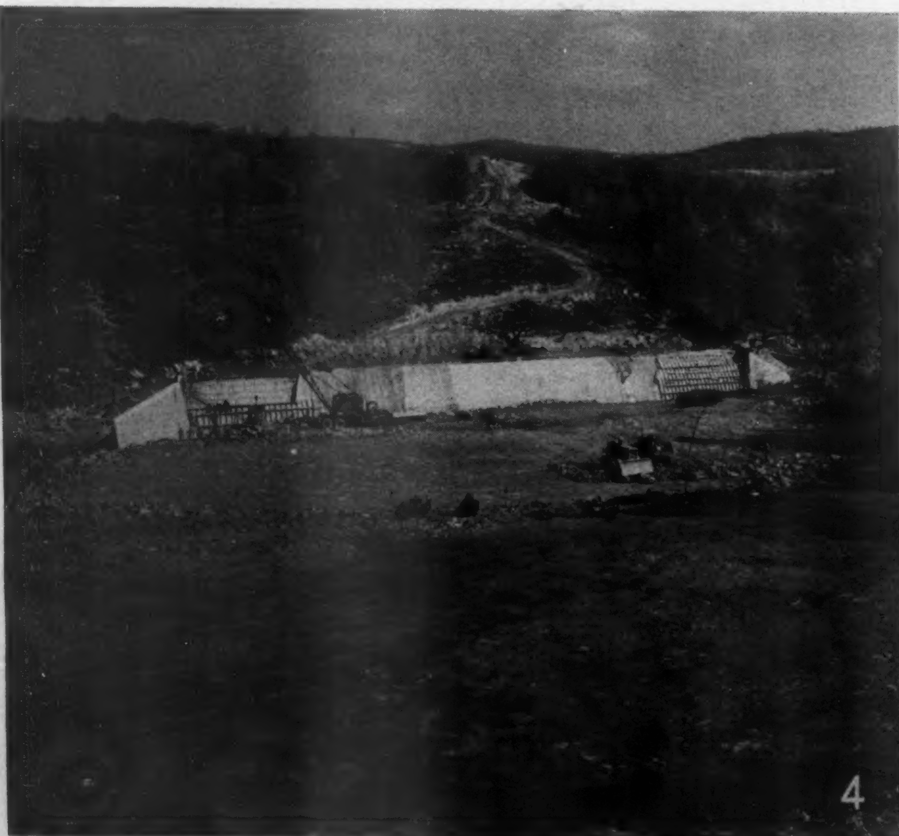
The chairman of the Niagara Falls Bridge Commission is the Hon. T. B. McQuesten, K. C., and C. Ellison Kaumeyer is executive secretary. Waddell & Hardesty, of New York City, and the Edward P. Lupfer Corporation, of Buffalo, are the designing engineers and consulting engineers, respectively. The McLain Construction Company built the foundations and the concrete approach structure on the New York side, and Aiken & McLachlan, Ltd., of St. Catherines, Ont., did the corresponding work on the Canadian side. The Bethlehem Steel Company has been the contractor and erector for the steel span, and the Canadian Bridge Company, of Walkerville, Ont., has been associated with it in fabricating such of the steelwork as could be manufactured in Canada. The American approaches have been financed by the New York Frontier Park Commission, and the Highway Department of Ontario is responsible for the Canadian approaches.



Roadbuilding in the Pennsylvania Mountains

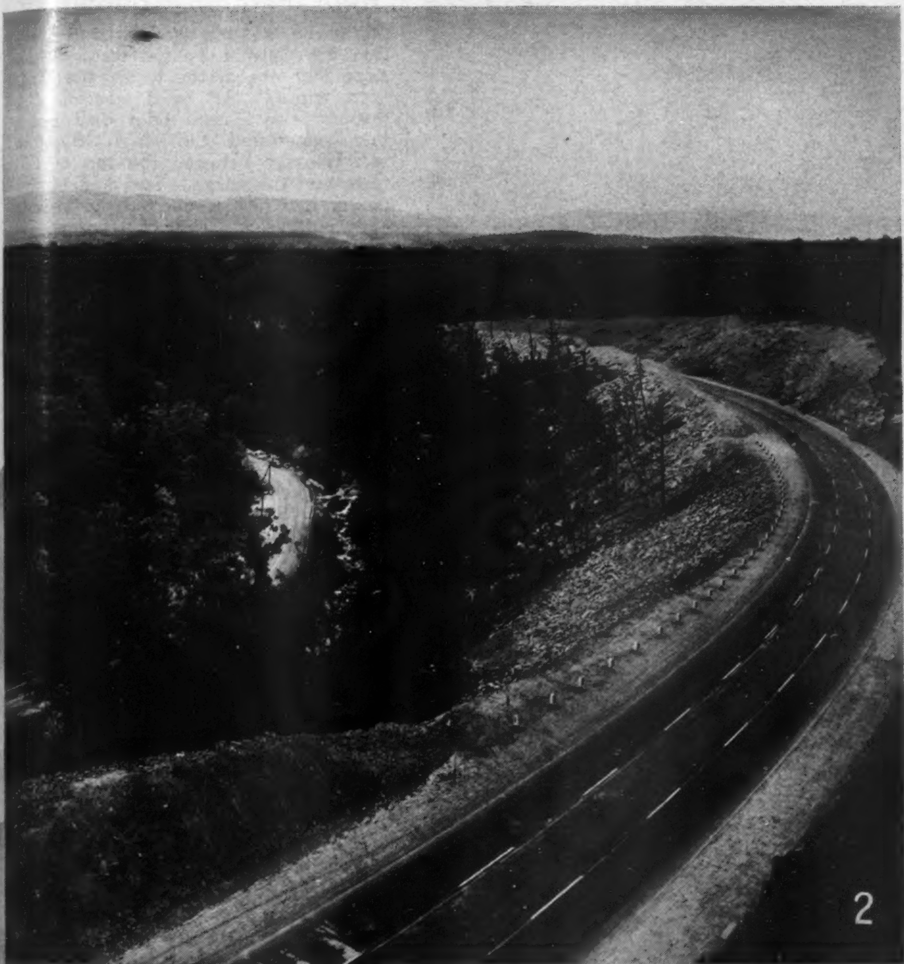
JUST a year ago we described the construction of a new 3.04-mile stretch of highway designed to relocate part of Route 115 eastward of Wilkes-Barre, Pa., for the purpose of eliminating dangerous grades and curves that had taken a heavy toll of lives. That work, which was carried out by Johnson, Drake & Piper, Inc., of Freeport, N.Y., under a $659,000 contract, has now been completed. Accompanying pictures show some of the changes wrought by the roadbuilders.

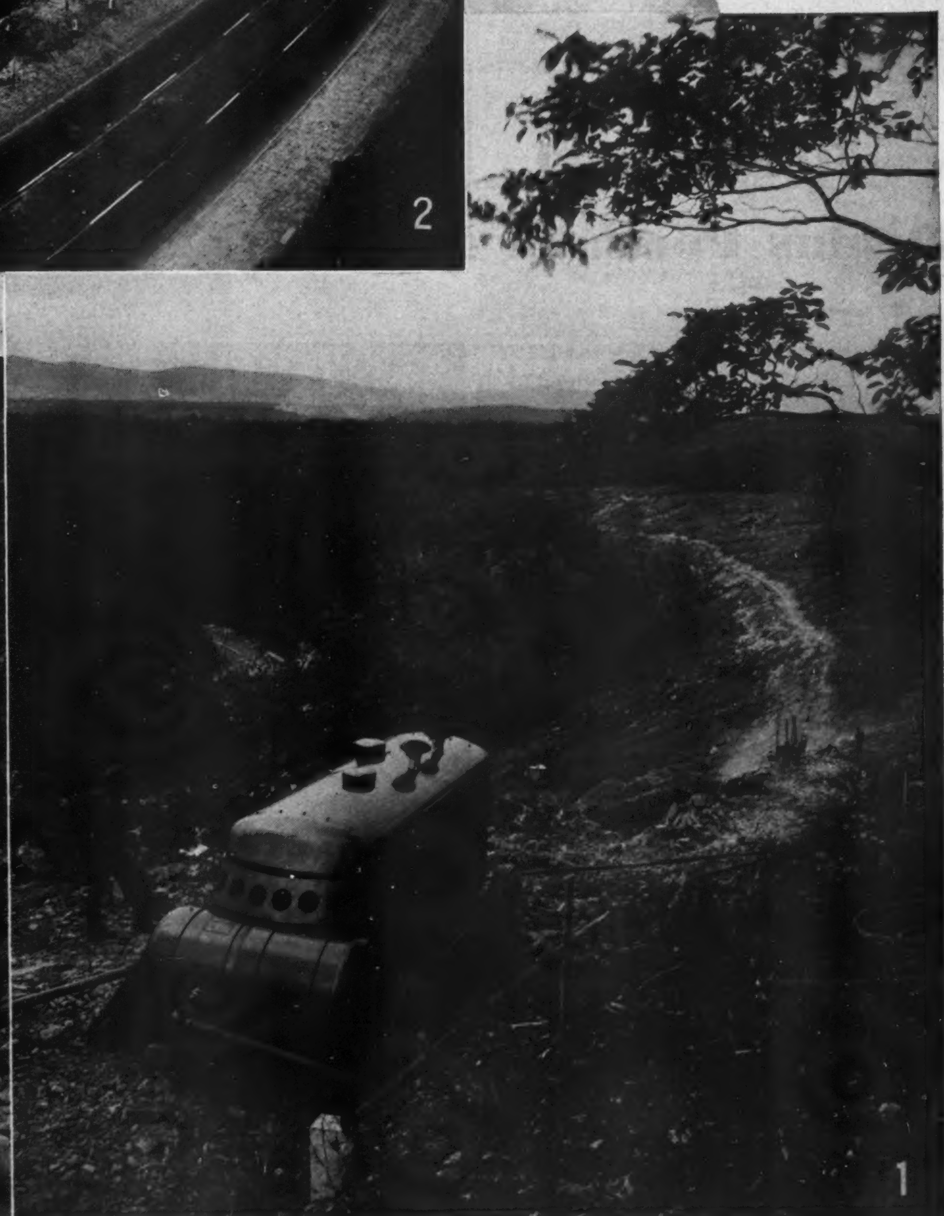
Approximately 603,000 cubic yards of material, 75 per cent of it rock, was excavated, and all but 40,000 cubic yards of it was utilized. Drill holes, ranging from 7 to 28 feet in depth, aggregated 480,000 feet, or nearly 90 miles, and called for the use of 398 pieces of drill steel and 52,740 individual detachable bits (new and resharpened). Blasting operations consumed 551,325 pounds of dynamite, 53,925 electric caps, 18,000 fuse caps, and 42,000 feet of fuse. The operation of portable compressors, trucks, and other mechanical equipment involved the use of 125,145 gallons of gasoline, 141,091 gallons of fuel oil, 14,046 gallons of lubricating oil, and 15,127 pounds of grease. The 3-lane concrete roadway, culverts, etc., required 23,556 barrels of cement.



BEFORE AND AFTER

Pictures 1 and 2 were taken from approximately the same spot but 11 months apart. To the left of the portable compressor in No. 1 was made a cut that is 101 feet high on the uphill side. Part of it is shown in No. 3. First constructing a concrete arch of 20-foot span and 249 feet long to carry Laurel Run, the contractor built up a fill containing 205,000 cubic yards of material across the stream. No. 4 shows the arch under construction and No. 5 the finished roadway.





UNDERGROUND CLOUDBURST

At the left, water is seen pouring down into the Carlton Tunnel through the raise that was driven to tap the Portland winze. All of it was coming through two 2-inch pilot drill holes that penetrated the final 18½-foot rock barrier between the top of the raise and the winze. The man in the center had just descended the ladder after putting in a shift of drilling. As the water had a temperature of 40°F., it was impossible to work more than three hours at a stretch. In the group picture are the machine men and chuck tenders who drove the raise. Standing at the right is Robert P. Welch, who directed the work. Next to him is R.L. Pestana, office manager of the Carlton Tunnel operations. The bottom picture shows Merrill E. Shoup (left), president, and A.H. Bebee, vice president in charge of mining, of the Golden Cycle Corporation which drove the Carlton Tunnel. It was taken during the 1940 Christmas season when the portal was decorated.

Carlton Tunnel Drains Portland Mine

ANOTHER chapter in the fascinating story of the Carlton Tunnel at Cripple Creek, Colo., was written with rock drills and dynamite on September 13, when a connection was successfully made with the lowermost workings of the Portland Mine and that property was quickly drained. This was accomplished by a difficult and arduous piece of mining engineering that was planned by A. H. Bebee, vice-president in charge of mining of the Golden Cycle Corporation.

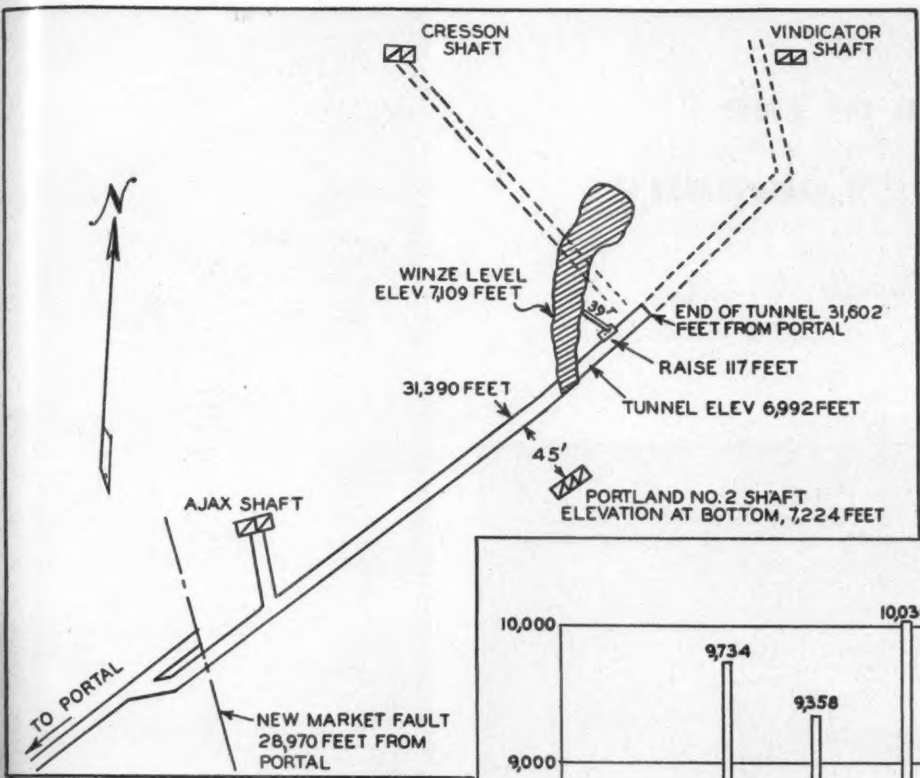
As told in our August issue, the Carlton deep drainage tunnel underneath the Cripple Creek mining area was officially completed on July 25, having been driven almost six miles in less than two years. Actually, the bore had been carried some 200 feet past its objective, a point beneath the Portland No.2 shaft. This was done to intersect the granite breccia contact which appears in the lower workings of the Portland, it being thought that this would expedite the drainage of the 700 feet of water standing in the Portland workings. The contact was cut at a distance of 31,602 feet from the portal, but the flow of water did not increase materially.

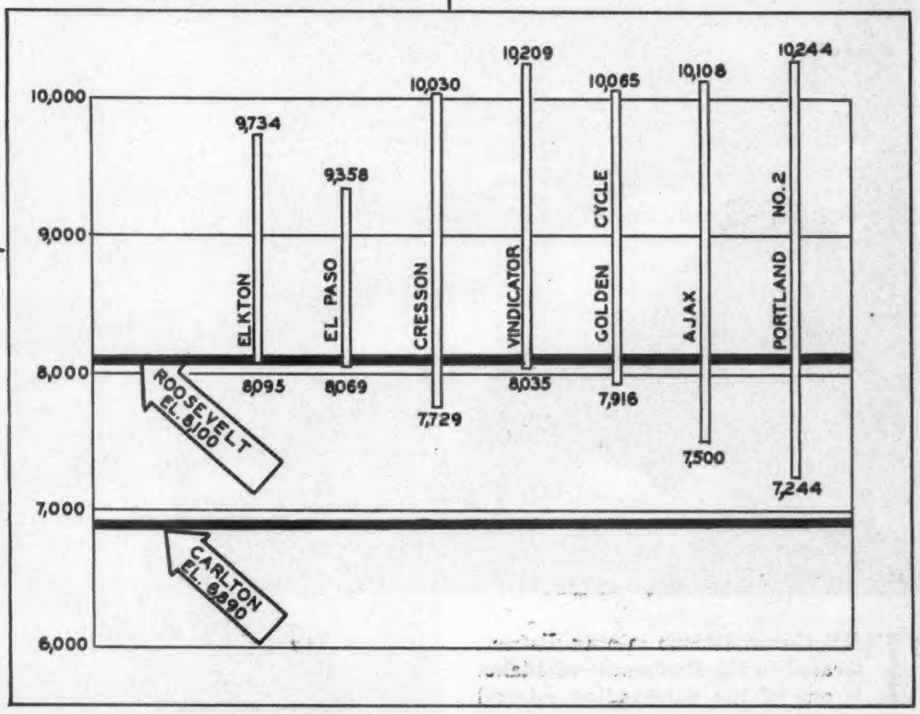
The regular tunneling crews then withdrew, but a small group in charge of Robert P. Welch, who was master mechanic during the tunneling operations, continued to probe the fault on both sides of the tunnel line in the hope of finding a watercourse that would loose the billions of gallons of water pent up above. When these explorations failed to produce the desired results, Bebee decided upon the bold move of driving a raise a vertical distance of 117 feet to a winze level that forms the bottom of the Portland workings.

Welch and his men set about doing this. Because of the great head of water standing in the shaft, it would obviously have been extremely hazardous to tap the vast reservoir from directly below. It was accordingly decided to drive the raise to a point on one side of and on the same level as the winze and then crosscut to the latter. In order that the work might be carried on in stable rock where there would be less chance of a sudden break-through of the water, the raise was started at a point 86 feet back from the tunnel heading in solid Pike's Peak granite. The 4x8-foot opening was not projected straight up. Instead, it was driven on a spiraling course with a 75° curvature to bring its top in line with the direction that the crosscut would have to take to intersect the winze-level workings.

When the level of the winze had been reached, it was calculated that exactly 39 feet of rock separated the raise from the objective. The crosscut was driven 20½ feet and, after surveys had been carefully checked, it was decided to drill a pilot hole the intervening distance. This 2-inch hole, put in with a DA-35 drifter, entered the Portland workings after penetrating 18½ feet, exactly as had been figured.

When the drill had been swung out of





PLAN AND ELEVATION SKETCHES

The drawing at the left shows the underground geography of the southeastern section of the Cripple Creek mining area and the course of the Carlton Tunnel. The projected laterals to the Cresson and Vindicator properties are indicated by dotted lines. The cross-hatched area is the winze level in the Portland workings with which a drainage connection was made, as described in the accompanying article. The drawing is not to scale. The other sketch shows the elevations of the Carlton Tunnel, the older Roosevelt Tunnel, and the tops and bottoms of the shafts of the principal mines in the district.

the way, the force of the water shot a 19-foot drill steel out of the hole with such velocity that it penetrated a 2-inch plank in the bulkheading and left a hole as clean as though it had been made by a bullet. Water spouted from the drill hole at the rate of 1,200 gpm. A second hole was then drilled into the winze workings. The flow of water increased, and it was determined that the water level in the Portland was dropping 1.3 feet an hour, as compared to a recession of 1 foot a day before the holes were drilled.

After considerable study, a safe method of attempting to break down the 18½-foot rock barrier was decided upon. About a dozen closely spaced holes were drilled within an area two feet square, all of them for a distance of 17 feet, or 1½ feet short of the winze. These were loaded with 60 per cent Gelex and primers, and the wires extending from the latter were run down the raise and connected with the tunnel lighting circuit running to the portal. All equipment was then removed from the tunnel and everyone withdrew. Although every effort had been made to reduce the gamble as much as possible, it was questionable just what effect the blast would have. If it failed to break out enough rock to increase the flow of water appreciably, the work done would have been lost, as it would have been too dangerous to attempt further drilling in the confined space of the crosscut with no knowledge as to when the water might break through under terrific pressure and engulf the workmen.

At 2:15 in the afternoon of September 13, Merrill E. Shoup, president of the Golden Cycle Corporation, stood at the portal of the tunnel and threw the switch that detonated the explosive. Then everyone awaited the result with bated breath. An hour and five minutes later, a wall of water four feet high came surging out of the 10x11-foot bore, spread out fanwise and overflowed the dump to a depth of two feet. The flow was estimated at 125,000 gpm. The Portland workings were drained in a matter of hours, and within 72 hours the discharge from the bore was down to its normal volume of about 7,000 gpm.

Since then a small force has been working on two shifts cleaning up the tunnel. The ventilating line and the compressed-air line were torn down and damaged in a number of places, many ties were washed out, and in one place the rails were turned over. As soon as the tunnel is ready for use again, the Portland No.2 shaft will be carried down to the tunnel level. This will call for 252 feet of vertical work and will probably be done by raising. The connection will provide ventilation for both the tunnel and the Portland workings and will permit lowering men and equipment through the Portland shaft to extend the tunnel. The latter operation will consist in driving to the Cresson and Vindicator mines laterals which will have approximate lengths of 4,000 and 5,000 feet, respectively. These galleries will be driven on the tunnel level. All machinery at the portal of the tunnel is being moved to the Portland shaft house. The Ajax Mine, which was unwatered when the tunnel cut the New Market Fault at a distance of 28,970 feet from the portal on February 20 of this year, is installing equipment preparatory to deepening its shaft, which is now bottomed approximately 500 feet above the tunnel level.

The successful tapping of the Portland water pocket insures complete success of the Carlton Tunnel project on which the Golden Cycle Corporation has spent more than $1,000,000 and which will call for the expenditure of a like sum to drive the projected laterals and deepen the mines.

The Saga of the Hecla Mining Company

H. W. Ingalls

THE Coeur d'Alene mining district, located in the Panhandle of Idaho, is one of the outstanding mineral regions of the West, and for several reasons. The known mineralized field is only about 50 miles square; but it is the largest silver-producing area in the United States, according to the 1940 *Minerals Yearbook* of the U. S. Bureau of Mines, and the nation's second largest lead producer. It is also not far behind the leaders in zinc output. The lower workings of some of its mines are from 500 to 1,000 feet below sea level; and in addition to its many big mines the district possesses one of the largest lead, silver, and zinc smelting plants in the West.

Among the more important producers is the Hecla Mining Company. Like many other industrial and mining enterprises that have grown up in this setting, Hecla started out on a shoestring. According to local legend, the original claims in the Hecla group were located by some enterprising citizens of Burke to acquire property on a proposed right-of-way for a railroad up the Burke Canyon, or Canyon Creek, from Wallace to the Tiger and Poorman mines. There were not

OLD AND NEW SURFACE PLANTS AND MILL

Between 1898, when the company was organized, and 1923, the Hecla surface buildings were steadily added to until they appeared as shown at the upper left. On July 13 of the latter year, all the structures were destroyed when a forest fire swept down the canyon. The picture in the circle shows the smoldering ruins of the Hecla plant after the flames had subsided. Fortunately, the management had covered the property with insurance and money was available to erect the fire-proof structures pictured above. They still serve efficiently. In this view the main street of Burke appears at the left. At the upper right is shown the Hecla milling plant at Gem which has a capacity of 850 tons of ore a day.

even any known surface mineral indications on the land: it was covered with a thick forest and a heavy overburden. In later years the claims were taken over by Finch & Campbell who owned the Standard and Mammoth mines a short distance down the canyon and who organized the Hecla Mining Company in 1898. Prospecting on the property had revealed a small quartz vein which showed some signs of ore after a large amount of work had been done; but there was nothing to indicate a strike.

In 1901, three years after the formation of the Hecla Company, Finch & Campbell sold all their Coeur d'Alene District mine interests to the Federal Mining & Smelting Company for a reported consideration of several million dollars. Both seller and buyer wanted to include Hecla Mining Company in the deal; but Finch & Campbell did not control enough Hecla stock to close this part of the transaction. That was where Jim "Hecla" Smith entered the scene. Smith, a businessman from Chicago, Ill., and a minority stockholder in Hecla, objected to the sale of the property to the Federal and obtained control of enough of the stock to block the deal. He was elected president of the Hecla Company and held that position until his death in 1908.

At the time of the Federal's entrance into the mining industry of the Coeur d'Alenes, James F. McCarthy was local manager of the Mammoth Mine for Wilson & McKay, who were then operating it. The Federal transaction terminated that job, and McCarthy joined Smith and became manager of Hecla. Upon Smith's death he also became president and retained both posts for 39 years, or until his death in March, 1940. L. E. Hanley, the present president and manager, joined the company as an assayer and bookkeeper in 1902 and has practically grown up with it. He was promoted successively to office manager, secretary, mine superintendent, assistant manager, vice-president, and then succeeded Mr. McCarthy as president and general manager.

During the mine's early years, Hecla stockholders could be counted on one's fingers: today they number 5,275 and are scattered the length and breadth of the United States and in some foreign countries. During the first half of 1941 it has paid dividends amounting to $450,000, or at the rate of 25 cents a share. In 1940 they came to $600,000. The total dividend record to June, 1941, is $24,155,000. The company's surface mine plant alone is valued at $2,000,000; and to the end of 1940 the property has yielded silver, lead, and zinc ore worth $72,745,255, according to official net smelter returns. The quantity of ore produced up to that time was 8,302,000 tons, from which was recovered 38,043,000 ounces of silver, 679,032 tons of lead, and 18,089 tons of zinc.

Ownership of Hecla stock certificates has created some surprising and fortunate situations. One of the most unusual was the case of Mary L. Humes who, for reasons known only to herself, purchased, or in some deal acquired, 5,000 shares of stock. Certificate No. 41 was issued in her

ATLAS MINE

This is Hecla's most recent attempt to develop new mining property in the Coeur d'Alene District. In an area near Mullan, Idaho, (shown in the distance) where there are no producing mines, the company has sunk an 800-foot shaft to explore a mineralized zone that reveals little value at the surface. Operations are still in the prospect stage. The Gold Hunter Mill is shown on the right.

name on May 30, 1892, and thereafter the whereabouts of Mary Humes became a mystery. Hecla officials were unable to locate her by mail, and dividend payments on her shares piled up in the First National Bank of Wallace until the sum reached $34,000. In 1918, twenty-six years later, Mary Humes reappeared and proved ownership. However, she became involved in a lawsuit with the Northwest Realty Company which attached the stock and tied up the funds through some legal entanglement not essential to this story. In the final settlement of the case, in the Shoshone County District Court, Mary Humes received 3,333 shares of stock and $22,666.67 in cash and the Northwest Realty Company 1,667 shares and $11,333.33.

Friday the thirteenth proved unlucky for Hecla, for on that day and date in July, 1923, a fire from an unknown cause started in frame residences in the upper part of Mace, a short distance down the canyon from the mine. A brisk wind quickly spread the flames to other structures, and soon the whole canyon was ablaze. Fire fighters fought the flames with high-pressure streams, and building after building was blown up with dynamite in an effort to check the blaze and prevent it from reaching the Hecla workings, but to no avail. The structures finally burst into flames that reddened the sky. The hoistmen stubbornly stayed at their posts and succeeded in getting everyone out of the mine down to the 1600-foot level; but before the men on the 2,000 level could be reached, the intense heat had melted the electric cables on the surface and cut off the power. The hoists had to be abandoned and the workers concerned had to climb manway ladders to safety. Not knowing what might be the conditions at the shaft collar, some of them climbed 3,500 feet to one of the mine openings high on the mountain above the surface plant and the fire. Fortunately, President McCarthy and the board of directors of Hecla had had the foresight to take out a $1,000,000 "use and occupancy" insurance policy. As a result, the plant was rebuilt with insurance money, this time of fireproof steel and concrete. Meanwhile, the company continued paying its regular quarterly dividends, which also came from insurance money. The amount actually collected on the policy was $690,000.

Several years ago Hecla directors and large stockholders decided to expand the scope of operations, and with this end in view started making investments in other mining-development enterprises. Their first major step was the purchase of the Star Mine in equal partnership with the Bunker Hill & Sullivan Mining & Concentrating Company with which they organized the Sullivan Mining Company. In reality they bought a lawsuit. The Star is the western continuation of the great Morning Mine vein system which produced $23,401,629.53, net earnings, from September, 1912, to the close of 1940 for the Federal Mining & Smelting Company and which had yielded several millions for Larson & Greenough prior to the time they sold it for $3,000,000 cash to the Federal. In ground adjoining the Star, Federal claimed apex and extralateral rights to the vein system. The resulting lawsuit was one of the most famous in mining history, and after years of legal battling was decided in favor of the Sullivan Mining Company.

Star ore is mostly zinc; and the property was practically undeveloped except through Federal's Morning Mine workings. It was necessary for Hecla and Bunker Hill to get great depth on the ore body, so they drove a deep crosscut, nearly 2 miles long, starting on the 2,000 level of the Hecla shaft. Many mining men predicted that they would be flooded out; but this menace was overcome by forcing cement grout under pressure into the watercourses encountered. To do this, long drill holes were driven to the water-bearing fissures from both sides and from the top and bottom of the tunnel heading.

Successful development of the Star necessitated many innovations in mining. Nearly everything connected with it was upside down from an operating standpoint. The ore body was opened on a deep level instead of at the top, and the material had to be lowered instead of hoisted. Today the bulk of the ore is mined from the top of a mountain at Mullan, lowered as much as 2,800 feet from different levels

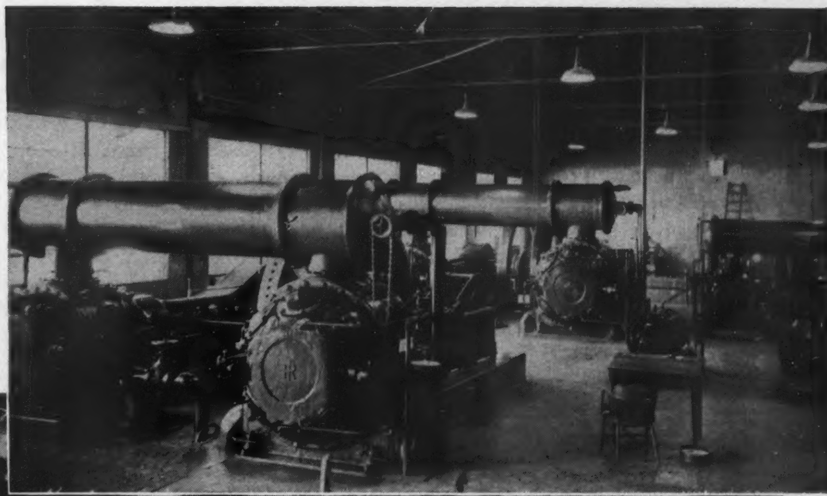
SULLIVAN ZINC PLANT

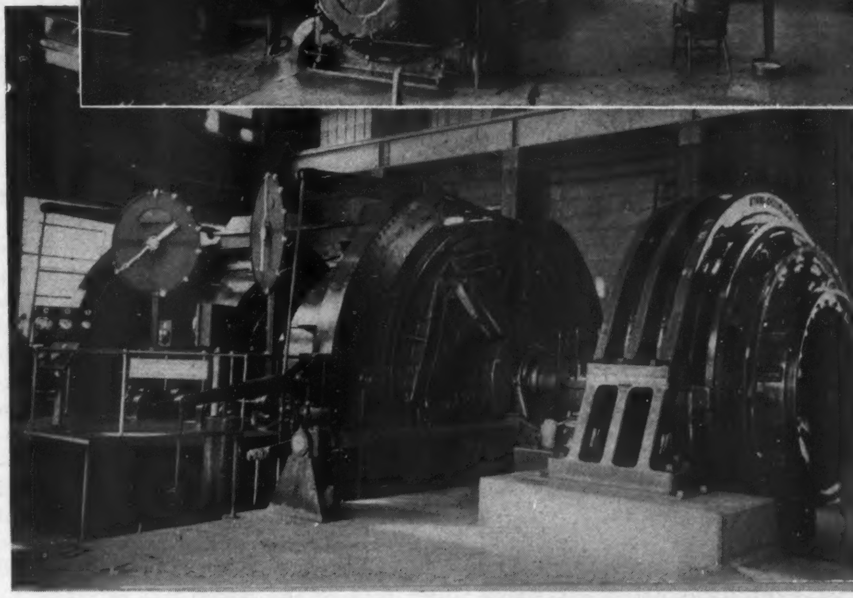
The Sullivan Mining Company, owned jointly by Hecla and the Bunker Hill & Sullivan interests, built this electrolytic zinc treatment plant at a cost of more than $3,000,000 and has now written off the cost of the investment. Here was produced the first almost chemically pure zinc ever made on a commercial scale in the United States. The plant turns out as much as 3,300 tons of slab zinc a month and employs 350 men.

to the main haulage crosscut, whisked through 2 miles of tunnel by electric train, and raised 2,000 feet to the Star mill at Burke. From there the concentrates are shipped 20 miles by railroad to the Bunker Hill smelter and Sullivan zinc plants at Kellogg. Star mill-building space near the collar of the Hecla shaft was limited because of Hecla construction, so the Star mill was built on a vertical plan, three stories high. The primary crushers are located on the bottom floor instead of the top, and the crushed ore must be elevated to the top of the mill by traveling belts before it begins its journey through ball mills, flotation machines, and filters to wind up as a finished product where it started, on the lower floor.

Hecla was the first Idaho company to experiment with the H. & H. sink-and-float process of ore concentration which, by sinking the ore and floating the waste, is the reverse of the flotation system. The primary purpose is to remove approximately one-third of the waste material before the ore enters the mill for standard flotation treatment. It is crushed to 1¼-inch size and separated into three classes: waste rock, which floats off the top; mineralized rock, which remains suspended in the parting liquid; and heavy ore, which sinks to the bottom. The Hecla tests have proved so successful that the process has also been adopted by the Bunker Hill Company which is building a sink-and-float unit at its Kellogg plant to handle 1,400 tons a day.

Star ore presented still another problem, that of recovering the zinc profitably in commercial form without paying heavy penalties for independent smelting. To accomplish this, Hecla and Bunker Hill, under the name of the Sullivan Mining Company, erected an electrolytic zinc plant in Government Gulch near the Bunker Hill smelter at Kellogg at an initial cost of $3,051,000. The natural site is perfect. It is located within a large horseshoe curve of a branch line that had previously been contructed by the Oregon-Washington Railroad & Navigation Company. The lower end of the curve joins the main line and the upper end connects directly with the Bunker Hill smelter. After much costly experimental work the plant succeeded in producing the first 99.99+ per cent zinc in the United States. It now employs 350 men and treats custom ore in addition to that from the Star. Capacity output is 3,100 to 3,300 tons of slab zinc a month. Some cadmium is obtained as a by-product.





MAIN HOIST AND COMPRESSOR PLANT

The Nordberg electric hoist at the Hecla Mine is the largest in the Coeur d'Alene District. The compressor room contains three direct-connected synchronous-motor-driven Ingersoll-Rand machines that have a combined capacity of 12,000 cfm. The air is discharged at a pressure of 100 pounds and is piped to the drilling machines a maximum distance of 14,900 feet.

POLARIS MINE

Hecla and the Newmont Mining Company jointly developed this silver mine, which adjoins the Sunshine Mine, largest silver producer in the country. Development work costing $800,000 was done before a pound of ore was produced. To the end of 1940, the mine had yielded nearly $3,000,000 worth of ore.

The Hecla and Star mines are intimately associated, although they are operated as separate units. The two properties are joined at a depth of 2,000 feet by a crosscut tunnel 8,900 feet long. Combined, they have approximately 50 miles of underground workings. Each has a milling plant with a capacity of 850 tons per day. Hecla employs 450 men and Star 330.

Electric power for both is transmitted by the Washington Water Power Company over a 3-phase, high-tension line 100 miles long. The connected load for Hecla equals 18,000 hp., and power consumption amounts to 1,500,000 kw-hrs. per month in addition to current developed independently at the mine by a 500-hp. hydroelectric station. Hecla's milling plant is situated at Gem, about a mile down the canyon from the mine, and uses 500,000 kw-hrs. per month.

Both mines are powered and equipped almost entirely with Ingersoll-Rand machinery, as are all other Hecla properties. At the Hecla shaft collar are three I-R compressors which deliver 12,000 cubic feet of air per minute at 100 pounds pressure. This is piped a maximum distance of 14,900 feet to the working faces. Also of Ingersoll-Rand make are the drills—numbering 183 stopers, Jackhamers, and drifters—as well as the pneumatic bars on which the machines are mounted. The steel is serviced by four I-R sharpeners, and I-R pumping equipment, handling 480 gpm., is depended upon to keep the mine free of water.

Hecla's deepest operating level is 2,800 feet below the collar of the shaft. From it a winze extends down 800 feet to the 3,600 level—the lowest point—which is 200 feet above sea level. From there the mine water is raised in three lifts by Motorpumps to the 2,800 level where are installed two 4-stage pumps powered by 200-hp. motors. These have a capacity of 500 gpm. working against an 800-foot head and lift the water to the 2,000 level where it is picked up by three 4-stage, 500-gpm. units, operated by 200-hp. motors against an 800-foot head, and delivered to the 1,200 level. From there it is elevated the remaining 1,200 feet to the surface by three 8-stage, 650-gpm. pumps driven by 300-hp. motors. These pumps have performed this continuous service for many years with a minimum of expense for repairs and have functioned so dependably that water has never interfered with the mining schedule.

Hecla's next mining venture was the Polaris property—a silver vein—adjoining the world-famous Sunshine Mine which is the largest silver producer in the United States. Together with the Newmont Mining Company of New York, Hecla invested $800,000 in Polaris before producing a pound of ore. The work included sinking a shaft 500 feet deep, driving an outlet tunnel 5,000 feet long, and building a mill with a daily capacity of 300 tons at a cost of $165,000. Up to the close of 1940, Polaris has yielded 188,000 dry tons of ore which has returned 4,421,000 ounces of silver having a net value of $2,933,000 and has paid dividends amounting to $280,000.

In mining Polaris ore bodies an apex situation arose in a V-shaped block of ground joining the Sunshine and Polaris mining properties. This ground is known as the "intervening area" and referred to by the miners as "No Man's Land." Rather than go to the expense of a lawsuit over the matter, the two companies agreed to mine the ore jointly, Polaris receiving 60 per cent of the net returns above the 1,700-foot level and Sunshine 40 per cent. Below that level the percentage is reversed, Sunshine getting 60 per cent and Polaris 40 per cent. Both companies have benefited materially by the compromise agreement. Polaris's well-equipped plant includes 34 Ingersoll-Rand rock drills and various I-R pumps.

Hecla has taken a few ventures outside the Coeur d'Alene District with more or less success; but among them is no noteworthy major development unless that in Colorado, where Hecla, Newmont, and others are engaged in building a mill and reopening the old Resurrection lead-silver property, proves to be the exception. Hecla's latest attempt at exploration in the Coeur d'Alenes is in a new section, on the Atlas mining property at Mullan, Idaho. With unproven geology, and with no producing mines anywhere near it, the company has completed the sinking of a model 4-compartment shaft, 800 feet deep, on a shear-zone mineral structure heavily capped with iron but showing little commercial ore in any of the surface outcrops. Within the past few months a crosscut has been driven from the 800-foot level and has revealed a mineral zone more than 50 feet wide. This development is still in the prospect stage; but Hecla is prepared to explore the deposit thoroughly. Should these efforts prove to be successful, they will probably lead to the opening up of a large mineralized area of the Coeur d'Alene District that has heretofore received little attention from mine operators.

PUMPS AND DRILL

Water is pumped from the Hecla Mine at the rate of approximately 480 gpm. Some of it originates at the lowest level, 3,600 feet below the shaft collar. The water is handled in several lifts by a number of Ingersoll-Rand pumps. At the right are shown two 4-stage units, each rated at 500 gpm. against 800 feet of head and driven by a 200-hp. motor. These are installed on the 2,000-foot level and raise the water to the 1200-foot level. The other picture shows an R-51 stoping drill in use in a stope of the Hecla Mine

Maine Being Dotted With Defense Airports

MAINE, the most easterly state of the Union, is today the scene of tremendous airport-building activity because, geographically, it is "on the line" for United States planes bound for Britain via Newfoundland. For the same reason Maine is a logical "reserve base" for a vast amount of air (as well as naval) equipment to be operated in North Atlantic waters. The list of flying fields completed or now being rushed to completion sounds like a roll call of upper New England vacation resorts—Eastport, Bar Harbor, Bangor, Old Town, Portland, Augusta, Millinocket, Caribou, Presque Isle, to name just a few of the more than 30 new airports that will make the state one of the best equipped in this respect in the country. These are not emergency landing places, but full-fledged airports, many of them capable of servicing fleets of big land planes.

Crossing runways of great width (the present standard is 500 feet) and a minimum length of 3,000 feet are being constructed, and at almost every site provision was made at the time of selection for the extension of the runways to 4,000 or 5,000 feet. The trend towards larger aircraft has proved the wisdom of this; and at several locations options for adjacent land were taken up and contracts altered in accordance with the longer runways while work was in progress on the original plans.

The $1,000,000 airport at Rockland is typical of those being built near many relatively small towns in Maine. It will have three 4,000-foot runways, extending, respectively, north-south, northwest-southeast, and northeast-southwest. Each crosses the two others, but not at a common center, and as a result a triangular island is created on which hangars and servicing facilities will be set up. Each runway will have a concrete landing strip, 150 feet wide, flanked by bituminous safety strips, each 175 feet wide.

The Rockland airport was started as a WPA project, but in the face of a dwindling supply of workmen, combined with an ever-increasing need for speed, a decision was made early last summer to have the bulk of the remaining rock and earth excavation done under contract. The WPA forces concentrated on clearing and grubbing, constructing the drainage system, and laying the 12-inch gravel sub-base on the rough-graded runways.

The drainage provisions are fairly extensive. A pond fed by a small brook originally occupied part of the site, and this was drained at the start of the operations while the course of the brook was permanently diverted by the use of nearly 600 feet of 48-inch reinforced-concrete pipe. Some 12,000 feet of perforated culvert pipe, 6 to 15 inches in diameter, will be laid alongside the runways.

SITE OF ROCKLAND AIRPORT

The upper picture shows a section of the 300-acre tract near Rockland which is being developed into one of 30 new air bases in Maine for national defense. It will have three concrete runways, each 4,000 feet long and 500 feet wide, arranged in different directions and forming a criss-cross pattern with a triangular space in the center where hangars and servicing facilities will be located. Construction work involved the excavating of 290,000 cubic yards of earth and 60,000 cubic yards of rock. The latter was drilled for the most part with wagon drills, as illustrated in the lower picture.

DIGGING DRAINAGE DITCHES

For adequately draining the site, a pond was filled in and a brook diverted through a 48-inch reinforced-concrete pipe. More than 2 miles of perforated metal piping, ranging from 6 to 15 inches in diameter, will be laid alongside the runways to carry off water. Rock encountered in digging trenches for the lines was drilled with Jackhamers, as pictured above. At the left are two of the men who are directing the work: W. E. Bramhall (left), superintendent for the WPA; and Tom Coyne, superintendent for Carlo Bianchi & Company, Inc., which was awarded the contract for excavating and grading.

In June of this year, Carlo Bianchi & Company, Inc., of Framingham, Mass., contracted for the excavation of 210,000 cubic yards of earth and 60,000 cubic yards of ledge rock, all of which was used in filling low spots to level the 300-acre field and to bring the runways roughly up to grade. This contract was based on 3,000-foot runways, and was later increased by 80,000 cubic yards of earth to meet the requirements of 4,000-foot runways.

New England contractors are quick to assert that Rockland was, indeed, well named. In the vicinity of this harbor town on famous Penobscot Bay are numerous outcroppings of such igneous rocks as quartz, chert (flint), and granite. Three large outcroppings had to be cleared away for the runways of the flying field. Jackhamers were first used in conjunction with wagon drills to drill blast holes in the areas; but the performance of the latter clearly indicated that the most rapid progress would be made by employing them exclusively. As a result, four FM-2 wagon drills mounting X-71 drifters did substantially all the rock-removal work. Each received air from its own 315-cfm. portable compressor. Jackbits and Jackrods were used for all drilling.

As was to be expected, considerable rock was encountered in the path of the drainage pipe, and Jackhamers were frequently called upon to drill the trench line for blasting. Present plans call for the completion of the drainage facilities and the spreading of the gravel sub-base on the runways during the winter months. Final paving of the latter will not be done until the spring, when the airport will be ready for service, even though construction of the permanent buildings will still be in progress. At this writing, Carlo Bianchi & Company, Inc., is finishing the rough grading, and the contractor's force and equipment are preparing to move on.

H. S. Salmon, Prominent Southern Engineer, Dies

HERBERT S. SALMON, a member of the Birmingham, Ala., firm of Salmon & Cowin, engineers and machinery dealers, died October 14 in a Birmingham hospital from complications following an operation. He was 53 years old.

Born in Frankfort, Ind., he was graduated from Purdue University and went to work for the Tennessee Coal, Iron & Railroad Company in Birmingham in 1907. He remained with that concern until 1922, when he became chief mining engineer for the Woodward Iron Company, also of Birmingham. In 1924 he joined P. G. Cowin in the organization of the firm of Salmon & Cowin, which has become well known during the intervening years throughout a large section of the South.

Mr. Salmon served from 1927 to 1932 as a member of the Jefferson County Court House Commission. He had also been a member of the Bituminous Coal Code Authority. At the time of his death he was chairman of the Bituminous Coal Board and president of Alabama Coals, Inc. He was an active member of the Engineers Club of Birmingham, the Kiwanis Club, and the American Institute of Mining & Metallurgical Engineers, of which he was past chairman of the Southeastern Section.

The Auto Goes Underground

SAN FRANCISCO is coping with a downtown automobile parking problem by constructing a subterranean garage underneath Union Square, a public park. The idea of underground storage has previously been carried out in Washington, D.C., and Salt Lake City, but this is believed to be the first time that property owned by a municipality has been utilized for such a purpose.

The parking problem in San Francisco is acute by reason of the city's many hills, its angling streets, and few alleys. Contiguous to the site of the new garage are 88 hotels, 80 restaurants, seven theaters, eleven professional buildings, and retail stores that are visited by an average of 85,000 shoppers daily.

The sunken building will have four floors, the lower three of which will have over-all dimensions of 412x275 feet. Because there is a difference in elevation of 24 feet between the highest and lowest points in the square, the top floor will be omitted on the lower side. The structure will be capable of housing 1,700 cars and there will be entrances and exits on each of the four streets bounding the square. Inside of it the traffic lanes will be arranged so that no two of them will cross, and four spiral ramps, two for descending and two for ascending, will lead to the lower levels. The upper floor will have little storage room, being designed primarily as a clearing space for handling and servicing automobiles.

On top of the garage will be placed from 2 to 5 feet of earth which will be sown to grass and planted with shrubbery and trees. In fact, a new landscaping plan is to be carried out, and the 750-ton statue commemorating Admiral Dewey's victory at Manila Bay during the Spanish-American War will be restored to the site in the center of the park that it has occupied for many years. In building the structure, consideration is being given to its possible use as a bomb shelter.

The garage is being constructed by a group of San Francisco businessmen who received a loan of $850,000 from the Reconstruction Finance Corporation for the purpose. The balance of $600,000 needed to defray the cost was raised by selling preferred stock to property owners in the vicinity of the site. The builders have been given a 50-year lease on the subsurface area and will pay the city $18,000 a year in rental and taxes. Ownership will pass to the city as soon as the cost has been returned in earnings. It is estimated that this will be accomplished in 25 years. The garage is expected to be ready for service next June.

ATTENTION, CAMERA FANS!

FOR the three most suitable photographs for cover illustrations that reach us before February 1, 1942, we will pay $40, $30, and $20, respectively. For others that are reproduced on the cover during the remaining months of 1942 we will pay $10 each.

The pictures submitted may pertain to any of the fields we cover. Human interest, as well as the photography, will be considered in judging them. Our cover size is approximately 7x7 inches. Smaller prints should be sufficiently clear and well defined to permit enlarging them. The sending of the negatives is suggested, as they will facilitate "blowing them up."

Each picture submitted should be accompanied by a description of 100 words or more. We will endeavor to return all unacceptable photographs.

Address: Editor, Compressed Air Magazine, Phillipsburg, N.J., U.S.A.

War the Disrupter

LITERALLY the whole world is fast becoming an arsenal and a granary for supplying the belligerents in Europe, Africa, and Asia with needed materials of one kind or another. The present conflict is more truly a world war than any ever waged before.

In times such as these one likes to dream of a languorous existence on some sun-bathed, isolated island where the Martian influence has not made itself felt. But the appalling truth is that there are no such islands left. This is brought home to us by a dispatch in *The New York Times* from Tahiti in the South Sea Islands. "Every island within a thousand miles of this Pacific Paradise is now on a full wartime basis," the correspondent writes.

The hundreds of dots of land that protrude above the water throughout a stretch of 2,800 miles from Australia to California are not only feeling the pinch of reduced imports from world markets but also are being called upon to send men and materials to the theaters of war. Tahiti, now under the flag of the Free French, has conscription, and has already sent brown-skinned men to General de Gaulle's army in Damascus. The streets of Papeete have become a drill ground for soldiers; and there are more than 200 secret police on the island. Anti-aircraft guns and cannon are manned for action at all times, and watchers are constantly on the alert for invaders.

From copra, the dried meat of the coconut, comes glycerine for making explosives, and on various islands are being mined phosphates—another essential war material. Last December an armed enemy freighter trained its guns on the Island of Nauru and temporarily put out of commission phosphate mines having a capacity of 1,000,000 tons annually. Cigarettes have become so scarce in the South Seas that they are being sold singly at the rate of $10 a carton, and there is no gasoline for private automobiles.

Calculator Determines Capacity of Proposed Power Plants

IN THE Westinghouse Electric & Manufacturing Company's East Pittsburgh Works there is what is called an alternating-current network calculator. As described by Mr. W.W. Parker of that company at the recent Pacific Coast Convention of the American Institute of Electrical Engineers, the equipment is contained in cabinets ranged along the walls of a large room and saves many weary hours of paper work in determining in advance of building how many and what size generators, together with the necessary transformers, power switches, etc., are needed for an electric generating station of a given capacity.

With the aid of the calculator, projected plants, or old ones that do not meet requirements, can be "laid out" in miniature and the most economical set-up established before buying equipment or making changes. It will also show if an existing transmission line can carry more power. One company, for example, which had decided to construct a new line when it was called upon to supply 40 per cent more current, found after a few hours' work with the calculator that the old one could carry the additional load and more by making certain simple modifications in apparatus and connections.

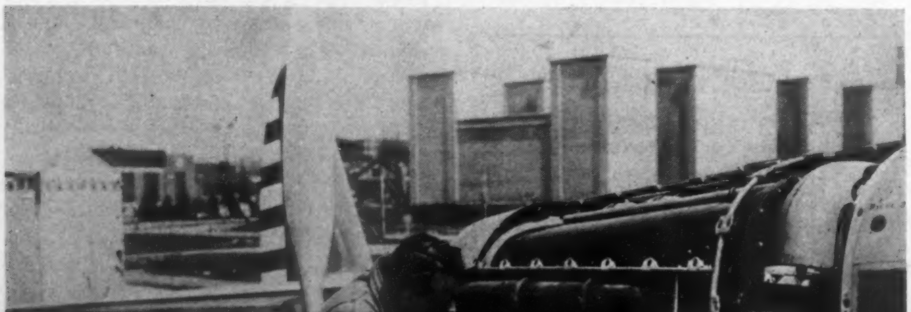
All this is done through the medium of coils and condensers that represent the powerful generators, transformers, transmission lines, and loads of an actual electric station. By inserting plugs, turning dials, and closing switches on panels on the fronts of the cabinets, the engineers can determine what machinery is required for a plant of a certain size or if the capacity of an old one can be increased without supplementing the equipment. Up to the end of last year, to quote Mr. Parker, the Westinghouse calculator has been used to study more than 400 power systems with an estimated saving, compared with paper work, of 1,200,000 man-hours. Last year the company engineered the construction of two such units for public utilities in Washington, D.C., and Canada.

Factory-Made Partitions

PREFABRICATED, nonload-bearing partitions for buildings of all kinds are one of the new products of the Reynolds Metals Company. The assembly is known as the Reyn-o-Wall System by which everything but the plaster is furnished ready for erection. The core of the partition is made up of two corrugated, laminated membranes laid together to form a hollow member and is reinforced on both sides, vertically by steel ribs and horizontally by cold-drawn wire. These wall sections are 35 inches wide, allowing for a 4-inch lap, are ⅜ inch thick, and come in lengths for ceiling heights up to 14 feet. They are held securely in place by means of a metal box base anchored to the floor and by perforated steel ceiling runners. After they are in position they are plastered with a scratch coat, a brown coat, and a white finish coat, using gypsum cement or portland cement mortar. The advantage of this type of construction, as compared with ordinary nonload-bearing partitions, is that the required strength and rigidity are obtained at a considerable reduction in weight. In addition, the monolithic slab is said to deaden sound and to be highly resistant to fire.

READY FOR ERECTION

Core section set up, showing how overlapping members are joined by slipping U-shaped anchor clips through the reinforcing wire. At top and bottom, right, are seen the perforated ceiling runner to which the wall is tied and the metal base with projecting diaphragms which serve to align the partition and to hold it firmly.



SPRAY GUNS PROTECT PLANE ENGINES

At military airfields throughout the country, every fighter plane and bomber that has been out of service for a week or more has its engines sprayed with an anti-corrosion compound containing castor oil. The picture shows a DeVilbiss gun being used for this purpose at Wright Field, Dayton, Ohio. Other uses of spray-painting equipment in connection with military aircraft include the application of protective and decorative coatings, both inside and outside the planes, the spraying of nonreflecting paint on the nacelle and propellers to prevent glare, and the application of sound deadeners inside fuselages to kill motor vibration.

Air Whistle that "Puffs"

AN AIR whistle for ships that gives both an audible and a visible signal was demonstrated recently by its inventor, John Hays Hammond. Mounted 80 feet up on the mainmast of his yacht *Odysseus III*, the whistle when sounded emitted a dense white plume some 30 feet long that remained in view long after the blast had died away. The cloud is obtained by the use of aluminum stearate stored in a metal cylinder that can be attached to any air whistle. When the latter is blown upon the pressure of a button, the air simultaneously ejects some of the finely ground powder, which forms a steamlike mass that is unaffected for some time by heat and humidity and can be seen in any weather except impenetrable fog. Not being luminous, the cloud is of no assistance at night without the aid of lights. A visible signal, according to Mr. Hammond, is an aid to navigation because it can be traced when many whistles are blowing at the same time and it is difficult to distinguish one from another.

Industrial Notes

Aluminum is being used abroad as a substitute for lead in sheathing power and telephone cables, according to *Foreign Commerce Weekly*. Among the advantages claimed for it are a fourfold increase in tensile strength and a reduction of 25 per cent in wall thickness.

Cushiontone is the trade name of a new low-cost acoustical material that has been put on the market by the Armstrong Cork Company. It is made of a fibrous composition of unusual density and has 484 deep perforations per square foot. It is said that noise can be reduced as much as 75 per cent by its use.

For those who must work in places where the floor or ground is continually wet or cold, Protex Products makes a foot covering of thin, pliable Pliofilm, a new synthetic material. It is worn over the stockings, but also can be used as a slipper in public showers, etc., for protection against athlete's foot.

Motor trucks that can run from roads on to tracks and *vice versa* without the driver leaving his seat are featured by the Dodge Division of the Chrysler Corporation. They are equipped with Evans Auto-Railers, retractable flanged pilot wheels, one at the front and one at the rear, that keep the truck on the track and assist the regular wheels to support the load.

To supply clean drinking water to workmen in the field, the Dixie-Vortex Company is making a portable water tank with or without holders for individual paper cups and used cups. The tank holds 4 gallons and is curved to facilitate carrying it by a strap slung over the shoulder. The cup dispenser and attached waste-cup receptacle can be obtained as a separate unit with strap attached.

According to a recent announcement, the National Bureau of Standards has established a laboratory for the purpose of providing means for making cotton proof against mildew. The step was taken as a result of the decision of the War Department to use cotton instead of jute for the making of sandbags. At the same time, the Department of Agriculture, which is said to have developed mildew-proofing agents, is continuing its research work in this field.

Under the trade name of Unichrome, United Chromium, Inc., is offering licenses for a copper-plating process by which coatings 0.001 inch or more thick can, it is said, be applied without the use of brighteners, wetting agents, or special additives. The bath is a mildly alkaline bivalent copper solution that is agitated with compressed air in a rubber or brick-lined steel tank. The deposit is said to be smooth and fine-grained and can be readily buffed or serve without buffing as a base for bright nickel plate.

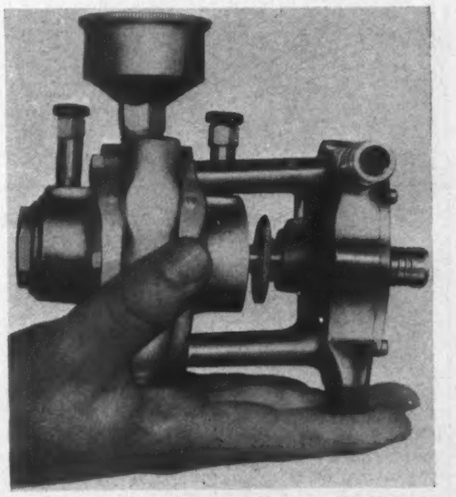
What is believed to be the largest single ore train ever hauled anywhere was recently made up in Cleveland by the Pennsylvania Railroad. It numbered 125 cars and carried a load of 13,568 tons. Four engines—two to push and two to pull—were needed until the slope stretching south from Lake Erie for a distance of 30 miles had been negotiated. From then on two engines hauled the long string of cars to its destination. It is estimated that when the 1941 shipping season ends sometime this month the total tonnage moved from lake ports will have reached a total of 80,000,000.

Discarded steel pipes filled with concrete make good pit props, according to the National Association of Colliery Managers. To give them added strength the concrete is compacted by the simple expedient of standing the pipes on a channel bar mounted on four springs and vibrated by a pneumatic pick. This contrivance was rigged up by the engineer of a coal mine that has some 150 of these props in service. Timber plugs are used to seal the pipes. In another colliery, where similar equipment has been set up, steel bands are welded around the ends of the pipes to prevent the plugs from bursting them.

An interesting development in lens glass is announced by the Eastman Kodak Company. The new product is made without silica, strange as it may seem. As a substitute are used tungsten, tantalum, and a rare metallic element known as lanthanum. We are told that the resultant glass bends light more than do ordinary lenses and, in aerial cameras, serves as an eye that records a wider area and gives a sharper picture. The substance was perfected about twelve months ago and is the outcome of seven years of research. The material is not yet available to the public; but lenses for aerial photography have been made of it for the U.S. Government.

Bus and truck drivers that have the bad habit of starting and stopping with a jerk will in future be on the spot, for the Drivometer will tell on them. The instrument was devised by the Electric Service Supplies Company to prevent passenger accidents, damaged shipments, and frequent visits of the vehicles to the maintenance shop. It consists essentially of two balls, of two metal tracks, and of two mechanical counters, all housed in a small steel case that is screwed to the floor of the cab or to a bracket where it is in plain view of the operator. One track slopes upward toward the front, the other toward the rear of the truck, and each time the latter is either accelerated or slowed down with a jerk a ball rolls up one incline or the other and moves the associate counter with a click that is audible to the driver. At the end of a day or trip he will know exactly how he has handled his vehicle, for the intrument will show the total number of both bad starts and stops he has made.

Eastern Engineering Company has announced an addition to its line of midget pumps designed for industrial and laboratory use where an explosion-proof unit is required and where compressed air is available. Eastern Model D, as it is designated, measures 5½x6x7 inches, weighs 10 pounds, and is operated by a ¼-hp., centrifugal air motor equipped with an exhaust silencer. Using air at from 20 to 100 pounds pressure, the unit



has a capacity of from 7½ to 15 gpm., and with the motor running at maximum speed, 4,000 rpm., the air consumption amounts to 5 cfm. The pumps are available in stainless steel, monel metal, chromium-plated bronze, brass, cast iron, hastelloy, and other alloys.

Primarily designed for determining the permeability of balloon fabrics—the rate of diffusion of helium or hydrogen through the material, the Fabric Permeameter made by the Cambridge Instrument Company has many other uses such as testing packaging materials for foodstuffs and doped airplane, gas-mask, and other fabrics that must be as leakproof as it is possible to make them. Permeability is established by clamping a sample between two recessed plates and by applying air on one side and hydrogen on the other side of the test piece. If any hydrogen leaks through it will contaminate the air, changing its thermal conductivity, and the amount of leakage is measured by a galvanometer in liters per square meter in 24 hours.

—AIR JETS—

"The boss says to drop everything and see him right away."

THE BALLAD OF MOKELUMNE ED.

DURING the Tertiary Age, great rivers flowed majestically to the sea. For thousands of years, erosion had been leveling the surrounding hills and the rain had washed the gold locked in their veins into these vast Tertiary channels. Then came flows of volcanic mud and lava and many of the stream beds were buried far below the present surface. In the Town of Columbia, Calif., the limestone bedrock of one of these old watercourses lies exposed. The scene of great mining activity in the early days, the town now dozes in the sunshine. At one point a little white church and a graveyard rest on the top of the only pile of gravel that had apparently been left untouched by the early placer miners. Around this plot of ground this ballad was written.

Of all the great men of the Mother Lode,
The greatest of all, 'tis said,
Was a flea-bitten codger without any hair
Whom they called Mokelumne Ed.
On the eight hundred foot of the Roarin' Mine
He stood at the end of a drift,
And spat wide and handsome and cursed the breast
Just left by the previous shift.
Not a color was there or a sulphuret,
Not a fissure to follow or trace;
He knew he had come to the end of his rope
As he studied that barren face.
So he went up on top and he fired the men,
He felt that life was a fake;
But he packed up his burro and started out
To make him another stake.
He wandered along to Columbia town,
A camp of an ancient day,
Where the lime stuck out like the stones on the graves
Of the men who had passed that way.
This little old town was a placer camp
And the old fellers sure were keen;
They had worked the diggings time and again
And scraped the bedrock clean.
And after them came the China horde
Who could live on a lima bean,
And they panned what little the white men left
Because it was barren or lean.
So there wasn't much chance for Mokelumne Ed.
In that land of the long ago,
Where the wraiths of the miners that swarmed the place
Seemed to pass in a ghostly row.
He sat himself down to his noonday lunch
In the graveyard close by the church
That rested high on a gravel bank
Like a white bird asleep on his perch.
And thus, as he sat on a crumbling stone,
With his feet on a grassy mound,
A thought flashed into his sunburned brain:
He was sitting on holy ground,
And the gravel that lay just under his feet
Was surely a virgin bed,
For the old chaps no matter how tough they were
Didn't sluice out the graves of their dead.
So he put up his camp close down by the creek
As a base for his furtive search,
And started a tunnel a long ways off
To end just under the church,
So that passers-by, who saw his work,
Would never suspect his lay;
They would think he was only another poor nut
Who was digging his life away.
For two long months he shoveled and trammed
And at last he reached his goal
Where the ancient channel would be exposed
At the end of his gopher hole.
But what did he find but a miner's pan
And close by a rusty pick?
And when he uncovered a whole mine car
He sure felt pretty sick.
For some old timer had figured the same,
And put in his secret bore,
And beaten Ed. to that sacred place
Just fifty years before.
And the moral of this little ballad
Is that life is a practical joke,
And there ain't no luck in robbing a church
Or stealing a blind man's poke.

—PROF. WALTER S. WEEKS
in The California Engineer

FEATS & FACTS
BY ROBERT GLUECK
AT A COST EXCEEDING $3,000,000.00 AN AVERAGE OF 100 MEN WORKED 8 HOURS A DAY FOR 6 YEARS TO COMPILE 60 VOLUMES OF DATA UPON TESTS MADE TO DETERMINE AN EFFICIENT AIR-BRAKING SYSTEM FOR FREIGHT CARS.
THE 200-INCH TELESCOPE ON MOUNT PALOMAR IN CALIFORNIA WEIGHS 520 TONS AND IS MORE THAN 8 STORIES HIGH, YET IT IS SO DELICATELY MOUNTED THAT IT CAN BE MOVED WITH ONE FINGER.
TESTING FACILITIES NOW BEING ESTABLISHED AT WRIGHT FIELD, DAYTON, OHIO, PRESAGE THE ARMY'S OBJECTIVE OF 8,000-HP AIRCRAFT ENGINES AND 45-FOOT PROPELLER BLADES TO BE USED FOR FUTURE BOMBERS, TROOP TRANSPORTS AND CARGO SHIPS.
HYDROLOGICAL INVESTIGATIONS INDICATE THAT AN ARMY-BUILT FLOOD CONTROL DAM ON THE MILLERS RIVER AT SOUTH ROYALSTON, MASS., WILL PROBABLY BE USED ONLY ONCE IN EVERY 100 YEARS. SECTIONS OF TWO STATE HIGHWAYS AND FOUR MILES OF RAILROAD WILL BE MOVED TO CONSTRUCT THE DAM, WHICH WILL IMPOUND NO WATER EXCEPT IN FLOOD EMERGENCIES.
A NEW 16-INCH COASTAL DEFENSE GUN, WHICH FIRES A ONE-TON PROJECTILE 30 MILES HAS A RECOIL MECHANISM POWERFUL ENOUGH TO STOP A 20-TON RAILROAD CAR TRAVELING 60 MILES PER HOUR IN 5 FEET.